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TUSKS AND THEIR USES.

By R. LYDEKKER, B.A. Cantab.

MANY mammals, such as the elephant, hippopotamus, and walrus, are furnished with one or two pairs of pointed conical or compressed teeth largely exceeding all the others in length, and to which the term "tusks" is usually applied. Lions and wolves likewise have two pairs of somewhat similarly enlarged teeth in the fore part of their jaws; and although these are proportionately smaller than in the animals above named, it will be obvious that in popular language it is difficult not to include them under the same general title. Using, then, the term "tusks" for all such enlarged simple teeth, it may be of interest to note the groups in which these attain their greatest development, and also endeavour to learn something regarding their uses. An especial interest attaches, indeed, to the subject, on account of the extreme beauty of many of these teeth, and also from the circumstance that it is these alone which yield the various descriptions of ivory.

In a great number of instances such tusks comprise a pair in both the upper and lower jaws, which are situated immediately behind the front, or incisor teeth, and, from their marked development in the dog tribe, are scientifically designated canine teeth; the name "eye-teeth" being also not unfrequently applied to them in popular language. Tusks of this sort are characterized by the circumstance that the lower one on each side bites in front of the upper one; while the latter is always the first tooth situated in the true upper jaw-bone, the incisors, or front teeth, being implanted in a more anteriorly situated bone known as the pre-maxilla. In any ordinary carnivorous mammal, such as a lion or a wolf, the upper tusk is considerably larger than the lower, although neither project beyond the edges of the muzzle when the jaws are closed. If we examine such tusks in a dried skull we shall find that their roots (which, as in all tusks, are simple) are completely closed; thus indicating that their growth ceased at a certain period of life. Moreover, we may notice that the upper and lower pairs of tusks do not abrade against one another to any marked extent, and that consequently their summits are only subject to the ordinary wear and tear necessarily undergone during use. In many other mammals the form and structure of these tusks is, however, very different. Take, for instance,

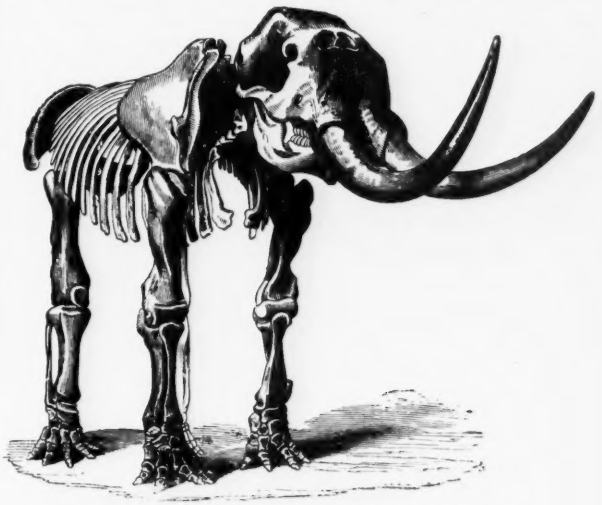


FIG. 1.—Skeleton of Mastodon to show single pair of tusks in upper jaw.

a wild boar, in which the upper tusks are short and curved upwards, while the larger and more slender lower pair abrade against their outer surfaces, and are thus worn to sharp, cutting edges. Obviously such tusks, if they were incapable of growth like those of the lion, would soon be worn away to mere stumps and become useless to their owners. To prevent this, the bases of the tusks remain permanently open (as shown in Fig. 4), and contain a soft pulp connected with the vascular structures of the jaw, in consequence of which the teeth continue to grow throughout life; their rate of growth thus keeping pace with that of the abrasion to which they are subject. Tusks may accordingly be divided into two classes, which we may designate hollow and solid. The open tusks referred to above are prevented from attaining any very great length by the abrasion of the lower against the upper pair, but in other cases, as in those of the remarkable pig of Celebes known as the babirusa (Fig. 2), no such abrasion takes place, and both pairs then attain enormous dimensions, projecting in this particular instance far above the upper surface of the head, and the down-curving points of the upper pair sometimes even penetrating the skull. A babirusa may in fact be compared to a wild boar in which one pair of tusks having been broken, the other continues to grow without any abrasion by wear; only that in these animals both pairs are thus developed. In the wild boar and its allies the tusks—more especially those of the lower jaw—are purely offensive and defensive weapons;

but it is hard indeed to imagine the use of those of the babirusa. Probably Mr. Wallace is right in regarding them as an ultra-development of organs originally useful,

FIG. 2.—Fore part of skull of Babirusa.

but which have now, from some reason or another, become of no functional advantage to their owner, and have thus, so to speak, run riot.

The babirusa presents us with an instance of a mammal in which both pairs of tusks have acquired their enormous development owing to the cessation of the mutual attrition between those of the upper and lower jaws, characterizing all its allies. On the other hand, in the mastodons and elephants we have examples where the development is normal, and either one or both pairs attain a vast size. In both species of existing elephants, as in many of the mastodons (Fig. 1), only the upper pair of tusks is thus developed; but in other mastodons these organs were present in both jaws, the upper pair being, however, always much larger than the lower. In the pigs and babirusa the tusks, of which the upper pair are planted in the true jaw-bone, correspond severally with those of the lion and the wolf, and are accordingly reckoned as canines. This, however, is not the case with those of the elephants and mastodons, which grow in great part from the pre-maxillary bone, and thus correspond with one pair of the front or incisor teeth of other mammals. Consequently, much as they resemble them in general appearance, the tusks of an elephant are not homologous with those of a pig or a babirusa. As we have entered in some detail into the structure of the tusks of the elephants in a previous article devoted to that group of animals, it will be unnecessary to recapitulate the facts here; although we may mention that in modern elephants these organs consist wholly of ivory, without any investing coat of enamel. The tusks of these animals, which belong to the hollow type, are the largest developments of dental structure to be met with in the whole animal kingdom. To a great extent these organs are weapons of defence and offence, but in the African species, where they are common to both sexes, they are also largely used in grubbing up roots and overturning trees; while in an extinct species from India their length is so great that they must have quite ceased to be useful, and were probably an actual encumbrance. Another allied extinct animal, known as the dinothere, is unique in having a large pair of downwardly-bent tusks in the lower jaw and none in the upper; the use of these being very difficult to conjecture.

A still more remarkable condition obtains in the hippopotamus, in which not only are the canine teeth developed into an enormous pair of hollow, ever-growing, curved tusks in each jaw, but the central pair of lower front or incisor teeth are so enlarged as likewise to merit the title of tusks. These incisor-tusks—which thus correspond to the lower pair of the four-tusked mastodons—are likewise of permanent growth, and project forwards from the front of the jaw in the form of two elongated cones. In thus possessing three pairs of tusks the hippopotamus is quite peculiar among animals. Largely employed for tearing up the grasses on which these monsters feed, the tusks of the hippopotami are also most effectual offensive weapons.

In the land carnivores, of which more anon, the tusks are always of the closed type; but in their aquatic ally, the walrus, we again meet with a huge pair of ever-growing tusks directed downwards from the upper jaw. On comparing the head of a walrus with that of an elephant, most persons would say at once that the tusks of the two animals were homologous. In this, however, they would be wrong, since, as we learn from the condition in the young animal, those of the walrus are true canines, whereas, as we have seen, the tusks of the elephant are incisors. We have here, therefore, a well-marked instance of the parallel development of severally dissimilar structures to attain a marked general similarity. The tusks of the walrus, which in old animals attain a great length, are mainly employed in digging up molluscs and crustaceans from the sand and shingle, and also, it is said, in aiding their owners to clamber up on the ice.

Although the whalebone-whales are entirely deficient in teeth and many of the dolphins and their allies have these

FIG. 3.—The Narwhal. (After True.)

organs but poorly developed, there are two cetaceans which exhibit a most remarkable development of tusks. The first of these creatures is the well-known narwhal, of the Arctic seas, in which, as a rule, there is a huge spirally-twisted cylindrical tusk projecting from the left side of the upper jaw of the male, which continues to grow throughout life. Whether this solitary tusk is a canine or an incisor is not very easy to determine; but it is remarkable that its fellow of the opposite side generally remains concealed in the jaw-bone, like the kernel of a nut in its shell, while in the female both teeth are thus rudimentary. Occasionally, however, male narwhals are met with in which both the right and left tusks are developed; and it is somewhat curious that in such cases the direction of the spiral in the two tusks is the same, instead of being, as in the horns of antelopes, opposite. Although narwhals have never been known to charge and pierce ships with their tusks, after the manner of sword-fish, it is still uncertain whether these formidable weapons (which may attain a length of from eight to nine feet) are normally used for purposes of attack, or for procuring food. Doubtless, however, the narwhal's tusk is of some use to its owner; but in another cetacean, known as Layard's

mesoplodon, the tusks appear not only useless, but actually harmful. In the whale in question, which is a rare species from the southern seas, there is but one large strap-like tusk on each side of the middle of the lower jaw, both of these curving upwards and inwards over the snout, so as to prevent the mouth from opening to its full extent. The only possible use we could suggest of such a structure would be to prevent the creature dislocating its jaw by yawning; but as other animals manage to get on without such an arrangement, this is scarcely likely to be a solution of the problem. It is more probable, indeed, that we have here to do with another instance of ultra, or monstrous development.

Other examples of hollow or permanently growing tusks occur among the hoofed mammals, other than the pigs, in all of which these teeth are found only in the upper jaw, and are developed chiefly or solely in the males. Among recent forms these tusks attain their greatest development in the little musk-deer of the Himalaya, where they are frequently over three inches in length, and project considerably below the lower jaw. In form they are sabre-like, and recall the upper tusks of the feline carnivores, only being more slender, and growing permanently. Similar but smaller tusks are met with in the Chinese water-deer, in the Indian muntjac, and the little deer-like animals known as chevrotains. The latter belonging to a totally distinct group from the others, it is evident that these scimitar-like tusks have been independently acquired in the two groups; while it is quite probable that those of the musk-deer and Chinese water-deer are likewise of separate origin. With the exception of the muntjac, in which they are very small, all these deer-like animals are devoid of antlers; and it is thus evident that their tusks have been developed in lieu of those weapons. It is true, indeed, that the males of some of the antlered deer have small tusks, but these are of no use for offensive purposes, and are evidently organs in process of degeneration. Moreover, in the hollow-horned ruminants, such as oxen and antelopes, where the horns are permanent and generally present in both sexes, not a vestige of tusks remains.

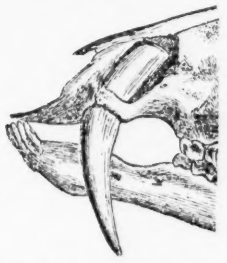


FIG. 4.—Extremity of the skull of a young Chinese Water-Deer, with the base of the tusk exposed. (After Sir V. Brooke.)

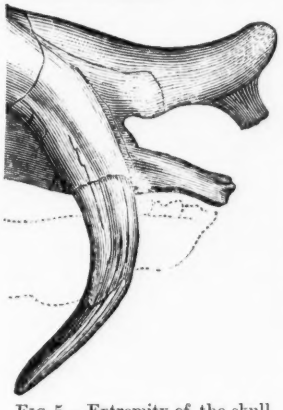


FIG. 5.—Extremity of the skull of a Uintathere.

Although the Asiatic rhinoceroses have procumbent tusks of considerable size in the lower jaw, none of the odd-toed hoofed mammals, such as horses and tapirs, have upper tusks of any size. In past times there were, however, in North America a group of somewhat allied creatures known as uintatheres, in which an enormous pair of upper tusks, somewhat like those of the musk-deer, was developed. Like those of the latter, these tusks grew permanently, and they were also protected by a descending flange of the lower jaw, which was often deeper than in the figured example. As these animals had front teeth only in the lower jaw, we have here, therefore, another curious instance of the parallel development of similar conditions in totally unconnected groups. What use these creatures could have made of their tusks is, however, not very clear, as in the living condition they could have projected but little below the lower jaw, while they were too long to have been effectual when the mouth was open. These uintatheres were also noteworthy on account of having a number of bony projections on the top of the skull, which in life may have been sheathed in horn; and it is not a little remarkable that another extinct creature—*Protoceras*—belonging to the even-toed group of hoofed mammals had a skull with very similar bony projections and also similar upper tusks.

Our last instance of animals furnished with permanently growing upper tusks is afforded by the reptilian class, in which the extinct South African creatures described many years ago by the late Sir R. Owen, under the name of *Dicynodon*, are thus armed. In these reptiles, some of which attained gigantic dimensions, the jaws were mainly sheathed in horn like those of the turtle; the single pair of tusks curving downwards and forwards from near the middle of the upper one. Possibly these tusks were capable of being employed when the mouth was open, like those of lions or tigers; but otherwise it is difficult to see their use. Certain allied reptiles from the same formations, known as anomodonts, had a full series of teeth, with a large pair of tusks in the upper jaw, which may or may not have been rooted, but are exceedingly like those of certain carnivores. As these reptiles are not the direct ancestors of mammals, we have thus evidence of the acquisition of tusks in two distinct classes.

As regards solid tusks, or those in which the lower end is closed at a certain period coincident with the cessation of growth, almost the only mammals, save the rhinoceroses (where, as we have seen, there may be a forwardly-directed pair in the lower jaw) and some of the marsupials, in which they attain any marked development are the carnivores. Among these, the maximum size of tusks at the present day is attained in the larger felines, such as the lion, tiger, and leopard. In these animals the tusks are, however, never so much elongated as to bar the front of the open mouth; while very frequently their tearing power is increased by the hinder cutting edge being finely serrated. Their terrible effect in tearing and rending the animals upon which these fearsome carnivores prey is too well known to need further mention. During the tertiary period there existed certain carnivores nearly allied to the modern cats, but exhibiting a much greater development of the upper pair of tusks, with a corresponding reduction of those of the lower jaw. In these creatures, which are known as machærodonts, or sabre-toothed tigers, the upper tusks were greatly compressed and flattened, with serrations on one or both cutting edges; their length in a species of the approximate size of a tiger being upwards of seven inches. As in the uintatheres, the anterior end of the lower jaw had a descending flange to protect the end of the tusk. Manifestly, such enormous weapons would completely bar the sides of the open mouth, and consequently they could not be used in the manner of the tusks of a lion or tiger. It is still more difficult to imagine that these animals could have struck with their tusks projecting from below the closed mouth; and it would consequently seem that in this instance also the tusks attained a development which was harmful rather than advantageous—this conclusion being confirmed by the fact, for what it is worth, that the sabre-toothed tigers have become totally

extinct, while their less specialized allies continue to flourish.

Finally, as regards tusks in general, it appears that while in the land carnivores these are always canines, are present in both jaws, and have closed roots, in the other orders of mammals their development is apparently somewhat capricious, while they are very frequently present in only one jaw—almost invariably the upper—and continue to grow permanently. Moreover, they are almost as frequently incisors as they are canines; so that apparently similar tusks may be in nowise homologous with one another. Never developed to any size in animals with large cranial appendages in the form of antlers or horns, tusks are frequently wanting in those lacking the latter. Primitively their use was undoubtedly as weapons of attack and defence, or to aid in procuring vegetable food; but in many cases they have subsequently undergone a frequently sexual development beyond the needs of such purposes, and are thus in this respect analogous to the antlers of many stags. In other instances, however—and this in all the groups in which they occur—they have undergone a still further semi-monstrous development, rendering them if not actually harmful, probably in some cases inconvenient to their owners. Finally, the independent acquisition in closely allied or widely separated groups of mammals of tusks of very similar structure and appearance shows how little reliance is to be placed on external characters as indicative of relationship.

THE STORY OF θ ERIDANI.

By the Rev. T. D. ANDERSON,* D.Sc.

AT a distance of 32° from the South Pole, and with a right ascension of 1h. 34m., shines α Eridani, the eighth in brightness, photometry assures us, of all the stars on the sphere. Those who have occasion to consult star maps and catalogues will have noticed that to this star is given, besides its letter α, the formidable-looking name of Achernar. Achernar means in Arabic "the last in the river," and is a translation of the *eschatos tou potamou* of Ptolemy, such being the descriptive appellation given by that astronomer to a star catalogued by him as the 34th in Eridanus, and estimated by him as of the first magnitude—one of fifteen in all which he places in that rank.

That α Eridani is the *eschatos tou potamou* of Ptolemy has been almost invariably accepted by astronomers, for except it, there is no first magnitude star anywhere near the southern end of the great celestial river. And yet the difficulties attending this identification are insuperable. Ptolemy made his observations at Alexandria (lat. 31° N.) in the first half of the second century of our era, at which time α Eridani, which has, be it remarked, almost no proper motion, was only 22° distant from the South Pole, so that Ptolemy, to see it even on the horizon, would have had to ascend the Nile to the Second Cataract. A usual explanation has been that given by Bode in his edition of Ptolemy's Catalogue (page 84): "It may be asked how Ptolemy knew anything of α Eridani, since this star in his time never rose above the horizon at Alexandria, but even when on the meridian remained nearly 10° below the horizon. He must have learned about it only from the uncertain reports of travellers who had visited the southern regions of the then known world, and have inserted it in his catalogue accordingly." He consequently rejects as entirely erroneous the longitude and latitude of the *eschatos tou potamou* as given by Ptolemy.

But unfortunately for this view, we have received from antiquity a good deal more information about the Last in the River than the bare mention of its longitude and latitude in Ptolemy's Catalogue. It is one of the fifteen first magnitude stars whose risings and settings are given by Ptolemy in his Calendar, and in that work it is expressly stated (93D) that although it did not rise above the horizon where the sun's diurnal arc at midsummer is $15\frac{1}{2}$ hours (*i.e.*, lat. 45° N.), it did rise where the sun's diurnal arc at midsummer is only 15 hours (*i.e.*, lat. 41° N.) Nay more, Hipparchus, in his Commentary on Aratus, states that at lat. 37° N. the Last in the River, or as he calls it—his star nomenclature is much fuller and more sonorous than that of Ptolemy—the brightest and preceding and southernmost of all in the River, rose when 351° of the ecliptic was culminating, and set when 63° of the ecliptic was culminating (ed. Petavius, pages 241A and 244B); or in other words, it was in his time $42\frac{1}{2}$° distant from the South Pole.

When we bear in mind these statements of Hipparchus and Ptolemy, and remember also that α Eridani—the so-called Achernar—was in the time of Hipparchus only 21° from the South Pole, the belief becomes irresistible that we have here the case of a first magnitude star either ceasing to shine altogether or becoming reduced to a much lower magnitude. As for the latter alternative of a serious reduction in splendour during the course of 2000 years, it is certainly not unknown in the annals of astronomy.

Thus β Leonis is given by Ptolemy, both in the Almagest and in the Calendar, as of the first magnitude; at the end of last century it was still bright enough for Bode to classify it as of the 1—2 magnitude; but now it is only of the second. Thus also α Sagittarii, given by Ptolemy in his Calendar as of the second magnitude, and in the Almagest as of the 2—3 magnitude, was in Sufi's time (the tenth century) only of the 4—5 magnitude, and that astronomer was so much astonished at the discrepancy between his own estimate and that of Ptolemy that he thought some error must have crept into the current copies of the Almagest. For this opinion, however, although it is adopted by Schjellerup in his notes on Sufi, there appears to be absolutely no foundation. By the time of Lacaille α Sagittarii had recovered to the 3—4 magnitude. It is now usually estimated at 4·0.

The fate of Ptolemy's Last in the River has been much the same as that of β Leonis and α Sagittarii. The Last in the River—the real Achernar—is undoubtedly θ Eridani, a star estimated by Halley and Lacaille as of the third magnitude, and still remaining of that magnitude.

The great difficulty in the way of identifying θ Eridani with the *eschatos tou potamou* is that the position which we find in Ptolemy—and the same remark applies to the position deducible from the remarks of Hipparchus—does not answer to that of θ. The latitude which Ptolemy gives is almost exactly that of θ, but the longitude is nearly four degrees too great. Instead of $356\frac{1}{4}$°, Ptolemy gives 0° 10′. How the longitude should be so much in error would be very difficult to ascertain. The fact may be noted, however, that Ptolemy is more than once similarly wrong as regards stars that lie far south. His longitude of β Centauri is wrong to the extent of $2\frac{1}{2}$°, while the error in the case of Fomalhaut is about the same as in the case of the Last in the River, its latitude being given 2° too great—23° S. instead of 21° S.

But in the catalogue of Ulugh Beg (1437 A.D.) we find the Last in the River laid down as a first magnitude star, in a position answering to that of θ with almost

* It may interest readers of KNOWLEDGE to be reminded that Dr. Anderson is the keen observer who first detected the Nova Aurigæ as a stranger in the heavens on February 1st, 1892, when it was only a little above the fifth magnitude. He modestly announced the appearance of the new star to Dr. Copeland on an anonymous postcard, and the discovery was only debited to Dr. Anderson after subsequent inquiries.—A. C. RANYARD.

mathematical accuracy. Baily, accordingly, in his edition of Ulugh Beg's Catalogue (*Memoirs of the Royal Astronomical Society*, Vol. xiii.) identifies without hesitation the *eschatos tou potamou* with θ. This had been done long before by Halley in his *Catalogus Stellarum Australium*, and the wonder is how, with the great weight of Halley on the other side, the idea should ever have gained ground that α Eridani is the *eschatos tou potamou*.

We have also from the pen of Sufi (964 A.D.) a very clear description of the Last in the River. He has been describing the three closely-adjacent fourth magnitude stars Lacaille 1198, 1244, 1248 (often called respectively h, f and g Eridani *), and goes on to say :—

"The 34th star (in Eridanus) precedes these three, and the distance between it and that one of the three which is nearest to it" (*i.e.*, Lacaille 1198 or h Eridani) "is about 4 cubits" (*i.e.*, about 9° 20′ of arc; Sufi's cubit = 2° 20′: *vide* page 92 of Schjellerup's edition). "It is of the first magnitude. This is the star marked on the southern astrolabe and called Achernar. Preceding this bright star there are two others, one to the south, the other to the north. Ptolemy has not mentioned them. One of these stars is of the fourth magnitude, the other of the fifth. Following it, and at a distance of 2 cubits from it" (= 4° 40′ of arc), "there is a star of the fourth magnitude."

It needs only a glance at the map to see what star is meant by Sufi. The bright star that precedes h Eridani (Lacaille 1198), and is distant from it about 9° 20′ of arc, can only be θ Eridani. (The actual distance between the two stars is 9° 11′.) The two stars preceding θ—one of the fourth magnitude lying southwards, and one of the fifth magnitude lying northwards—are ι Eridani and υ Fornacis respectively. The fourth magnitude star that follows it is e Eridani (Lacaille 1060).

That the star intended by Sufi cannot possibly be α Eridani is evident from the fact that that star is distant from h Eridani, not four cubits but 27½° of arc, or more than eleven cubits. It is much to be regretted that Prof. Schjellerup, the able and industrious translator of Sufi, has allowed this to escape his notice, and helped in the preface and notes to his work to propagate the delusion that α Eridani is Ptolemy's Last in the River. It is, perhaps, too late now to restore to θ its ancient style and title of Achernar, but α at least should be made to yield up its usurped honours.

What rank did θ Eridani hold in the heavens in ancient and mediæval times? Sufi, in placing it among his first magnitude stars, places it in an exceedingly select circle, for he has only thirteen stars of undoubted first-class rank, the other eleven, besides β Leonis and the Last in the River, being Capella, Vega, Arcturus, Aldebaran, Regulus, Procyon, Rigel, Sirius, Fomalhaut, Canopus and α Centauri. He estimates Betelgeuse and Spica as 1—2, Altair and β Centauri as 2—1, and Pollux and Antares as only 2.

One fact about θ Eridani we shall probably never learn, unless a certain contingency occurs. The fact to be ascertained is, which of the two components of θ has faded? The contingency is that the star may brighten up again. In a few centuries it will be high enough above the horizon to be visible in Britain. Will it then shine upon our land in its pristine glory as Ptolemy saw it gleam over the sands of the desert, and Sufi watched its image dancing on the waters of the Tigris?

* Not h, g and ι, as stated by Prof. Schjellerup in his edition of Sufi.

GALLS AND THEIR OCCUPANTS.—I.

By E. A. BUTLER.

IN the recent articles on "Caterpillars' Dwellings," we have seen how certain insects use parts of plants for the double purpose of board and lodging, twisting the leaves into variously-shaped coverings, the interior of which is then eaten away. In all such cases the portion of the plant operated upon is a normal vegetable product, and our interest and admiration are called forth solely by the ingenuity and architectural skill with which the insect, always in its larval form, adapts for its own purposes the materials it finds ready to hand. We propose now to consider some far more remarkable instances of association between insects and plants, in which a suitable action on the part of the *parent* insect results in the production of an *abnormal* vegetable growth, destined to provide its offspring with both shelter and food. These abnormal growths are of the most varied forms, some of them appearing as mere swellings or unsightly excrescences, others as highly ornamental additions, resembling leaves or fruit; but whatever their form and appearance, they are all included under the one name "galls." By a gall, then, we are to understand any kind of abnormal vegetable growth which results from the puncture of a plant by an adult insect, and the insertion of an egg in the puncture, the vegetable growth thus formed nourishing and protecting the larva produced from the egg, and sheltering the pupa resulting from this, till the time of its emergence as a perfect insect. Some of these galls are among the most familiar of "common objects of the country," such *e.g.* as oak-apples, oak-spangles, and robins' cushions, while the gall-nuts of commerce, used in the manufacture of ink, owe their origin to a similar cause. In these cases, the presence of the insect inhabitant, shut up as it is in the centre of the gall, is very naturally often quite unsuspected, and the oak-apple, for example, looks superficially as much like the genuine fruit of the oak tree as the acorn itself. The nature of the gall produced is no doubt to some extent dependent upon the plant upon which it is found, but it is much more largely dependent upon the species of insect that produces it, for the same kind of insect always produces the same sort of gall, while different insects will produce galls of totally different character, not only on the same tree, but even side by side upon it, where the vegetable conditions must be precisely similar.

The insects which are responsible for the formation of these monstrosities are usually sombre-coloured, fly-like, insignificant creatures, which are commonly known as gall-flies. They belong chiefly to two orders: the Hymenoptera, or order of bees, wasps, and ants, and the Diptera, or two-winged flies. The former order, however, contains all the best known species. Some few galls are produced by insects of other orders, but the consideration of these we will defer for the present. Our first concern will be with the hymenopterous gall-producers. These will fall mainly into two families—the *Cynipidæ*, or gall-flies proper, and the *Tenthredinidæ*, or saw-flies. All the species of the former family are in some way or other connected with galls, while in the latter group the habit pertains to only a few.

It will give greater definiteness to our thoughts if we select one particular species of *Cynipidæ* as typical of the group, and none could be found better suited for the purpose than that which produces the so-called marble or Devonshire galls of the oak tree, *Cynips Kollari*. The galls are no doubt familiar objects to anyone who has

wandered along country lanes—perfectly spherical bodies growing on young oak trees (Fig. 1), at first green and soft, but becoming, later in the season, brown and very

FIG. 1.—Marble Gall of Oak.

hard, whence their popular name. They are one of the commonest of the very numerous galls to which the oak tree is liable, and are often extremely abundant. While the leaves are on the trees and the galls themselves are green, they are, of course, not so noticeable; but as they remain on the twigs after the fall of the leaves, and pass the winter in that position, they are at such times extremely conspicuous, and the stunted oak bushes that in many places form one of the chief constituents of the hedgerows are often crowded with the dark brown marble-like balls. So abundant are they, indeed, that they are often collected in thousands to be strung on wires and worked up into rustic baskets to hold ferns.

The originator of these vegetable marbles is a little brown-bodied fly (Fig. 2, A), with four clear transparent wings, a thoroughly typical gall-insect. It has a globose and hump-backed thorax, but the abdomen is the most remarkable part of the insect. This is short, but broad and deep, and attached to the thorax by a very short and slender stalk. It is of a rusty brown colour, darker at the base. The various segments of which it is composed are very disproportionately distributed, the second being by far the largest, occupying indeed about half the abdomen; while the others lap over one another like scales. Underneath, a sharp ridge runs longitudinally along the abdomen; this covers the ovipositor, which rises from the head of the abdomen instead of farther down, as is usually the case, but part of its length is coiled up inside. The short, deep, compressed, shining body is quite typical of a gall-fly, and is one of the structural points by which the insects are most easily recognized. The neuration of the wings, again, is peculiar and is an aid to identification.

With its ovipositor the gall-fly pricks a minute hole in a young leaf-bud of the oak, and deposits therein an egg. It is probable that some irritant fluid is instilled at the same time, since many of the Hymenoptera, as is well-known, secrete fluids of this kind, and it is difficult to account for the effects of the puncture except on such a hypothesis. Either then by this means, or in consequence of the mere presence of the egg, an irritation is produced in the vegetable tissue, which results in the speedy growth around the egg of a cellular mass of globular form, in a cavity in the centre of which reposes the egg. The mother fly by its puncture taps, as it were, the current of sap along the twig, and diverts its course so as to lead to a rapid multiplication of vegetable cells around the puncture; in an incredibly short time this appears as a green spherical mass of fleshy tissue, which has no functions with regard to the tree from which it grows, but is reserved exclusively for the insect's own use, or rather for that of its offspring, and apparently interferes scarcely at all with the general well-being of the tree. If, however, the attack be very severe, thousands of galls appearing on the same tree as the results of punctures by swarms of flies, the vitality of the tree is naturally lowered through the shutting off or shunting of so much of its energy, and the effect of this would be felt first of all in its reproductive processes, and the crop of acorns would in consequence be diminished.

During the early growth of the gall, the egg remains unhatched, so that the grub is not called into independent life till the materials for its support have been duly elaborated. But, strange to say, the egg does not develop solely at the expense of its own contents, as is usually the case, but actually *grows* through the absorption of nutrient fluid from the gall; so that, though in comparison with its parent, it is proportionately large to begin with, it is considerably larger before it is hatched. From it there issues a fat, fleshy, footless grub, which has to spend its whole life in the more or less spherical chamber, just of its own size, that occupies the centre of the gall, from the rest of which it is shut off by walls of a harder consistency. It subsists at the expense of the gall itself, and the food it absorbs appears to be wholly digested, so that the grub can afford to dispense with any terminal outlet to its digestive tract, and consequently no excrement accumulates, the cell remaining always beautifully clean.

In course of time the grub turns into a pupa, which looks like a mummy of the perfect insect, with wings, legs, and antennæ folded close to its sides. This occurs towards autumn, but meanwhile a great change has been taking place in the gall itself, which is now hard and woody, and brown outside, all traces of green having disappeared as it became drier and harder. When cut open at this stage, it is seen to be composed of a brown and more or less spongy tissue, bounded within and without by a hard woody layer, the spongy intermediate mass being arranged in a radiating way from the centre (Fig. 3, A).

FIG. 2.—(A) Gall Fly of Marble Gall (*Cynips Kollari.*) (B) Egg parasite (*Callimome regius*). A is enlarged two diameters; B, three and a half.

The pupa changes to the perfect gall-fly while still lying in the central chamber, absolutely imprisoned and without pathway of escape. Of course it has been in darkness all this time, and, therefore, needless to say, it has remained of a creamy white colour; all the air necessary for its respiration has apparently been obtained by transfusion through the mass of the gall, for no direct communication with the outside is perceptible. The fly, when ready to escape, eats a cylindrical burrow for itself along a radius of the sphere, and thus reaches the outside by the most

direct route. The gall does not necessarily drop at this juncture, and, as most of the flies emerge in the autumn, the majority of the galls found during the winter on the bare trees will have no inhabitant within, or rather no *legitimate* inhabitant, since, as we shall see presently, they may contain other kinds of insect life. But the presence of the circular hole caused by the escape of the fly will always distinguish empty galls from those which are still inhabited by the true owner. Sometimes the galls may be seen with a large excavation in one side; this is the work of the tomtits, which delight to feed on the gall-fly grubs.

Such in general is the history of a Kollari gall, but it is often complicated by the presence of parasites. These may be chiefly of two kinds, firstly, vegetable-feeding ones, *i.e.*, other kinds of gall-flies which take advantage of the large store of food contained in a Kollari gall, and save themselves the trouble of making galls of their own; and secondly, insect-eating ones, belonging to a family of parasitic Hymenoptera which are noted for their gorgeous metallic green and golden coloration—these will be parasitic on the gall-flies themselves, both the legitimate owners and the cuckoo-like invaders. On cutting open a Kollari gall, we sometimes see not merely the central cavity, which is appropriated to the true owner, but a number of other similar, if smaller, ones, scattered about in the substance of the gall (Fig. 3, B). These are the homes of parasitic gall-flies, *i.e.*, species of *Cynipidæ* which do not appear to have the power of producing by means of the puncture of their ovipositors the abnormal vegetable growth which constitutes a gall, and therefore lay their eggs in galls already formed by other species. The mother fly in such cases is not satisfied with introducing a single egg, but a dozen, or perhaps a score, will be inserted into the one gall. Mr. E. A. Fitch records rearing twenty-three specimens of a parasitic gall-fly from only a portion of a double gall, *i.e.*, one in which two galls that had been formed in close proximity had coalesced.

FIG. 3.—Sections of Marble Gall. A, showing larva of Gall Fly in its cell; B, showing cells of parasitic Gall Flies.

These parasites, or rather inquilines, as they are more appropriately called, develop early, while the gall is still growing, and it can be easily seen that in consequence of their numbers they absorb the sap of the gall as fast as it is produced, and hence arrest its growth; so that although it contains a large family of insects it remains considerably smaller than when tenanted by only one, the legitimate occupant. It is frequently possible to detect from the outside the presence of these inquilines; there is a minute swelling lighter than the ground colour, on the surface of the gall over the spot where the invader's cell is situated, and the slight scar caused by the puncture for oviposition may also be traced. Thus the one gall becomes the nursery of at least two different kinds of insects, which are distinct enough to be referred to separate genera.

But this is not all; wherever a strange insect intrudes, it may be the means of introducing with itself any parasites which are dependent upon it, and thus a third member is imported into the society, and besides this, the legitimate inhabitant may also entice parasites of its own which will most likely be of different species from the others, and thus a fourth member may be added to the community. These parasites (Fig. 2, B), truly so called, will very largely consist of members of the family *Chalcididæ*, which subsist upon the eggs and larvæ of insects, their eggs being often laid within those of other insects, the contents being devoured by the parasite. It stands to reason, therefore, that this tribe of parasites is composed of very minute species; but what they lack in size they make up in brilliancy, and, with their polished metallic green and golden skin, they may claim as a group a foremost rank amongst insects in splendour of adornment.

To summarize what has been said and to endeavour to put into realistic form the chief incidents in gall-life: we have seen how, in the first place, a dull-coloured gall-fly, looking round amongst the trees for a suitable spot in which to prompt Nature to rear an asylum for her young, punctures a minute hole in an oak bud, and lays therein an egg, thus giving rise to the abnormal growth which is to be put to the double use of nursery and provisions. But the developing gall is soon spied by a far smaller being, a gorgeous warrior-like egg-parasite, which is also prompted by the anxieties of maternity, and is surveying the country round to discover just such a growth as this, which she instinctively knows contains the object of her quest. She has a long ovipositor with which she punctures the gall and reaches its contained egg, and in this she lays her own and then departs, having frustrated the intention of her predecessor and determined that out of that gall shall proceed, not a gall-fly, but a chalcid. But meanwhile another being, of quite a different character, dull-coloured and sombre like the first arrival, is also prowling about, ready to take a mean advantage of the juicy store which the vigour of the oak has thrown out in response to the tiny puncture that was the first link in the chain of events. As soon as the growing gall is detected, she alights upon it, and piercing it again and again, deposits in each spot an egg, she on her part determining that that same gall shall bring forth, not *one* solitary gall-fly, but a whole family, though of a different sort from what was originally intended. But her intentions, again, are to a large extent doomed to disappointment, for other members of the glistening warrior-tribe of parasites are in the air, and only await the conclusion of her labours to advance to the attack, and introduce their own little eggs here and there, ringing the death-knell of a gall-fly at each puncture. And thus in due time there shall issue from that one marble-like gall, not its legitimate occupant, but such of the inquilines as escape the second invasion, and a whole stock of brilliant freebooters, each burrowing its way through the substance of the gall into the open air. Thus the old and deserted gall will stand on its stem after the winter, not pierced with a single hole as should have been its fate, but riddled with minuter punctures on all sides, thus bearing mute testimony to the tragedies of which it has been the scene. But even this result is not a foregone conclusion, and the struggle for existence may not be over at the stage indicated, for there are insectivorous birds also on the alert, and the tomtit may pounce down on the ill-fated gall while it is still thronged with life, tear it to pieces, and devour all its inhabitants, leaving only the fragments of its walls standing like the ruins of a bombarded castle which has been attacked by a hostile force and has suffered the massacre of its entire garrison.

But the relations of our Kollari gall with insect life are hardly yet exhausted. If large numbers of these galls are collected in winter and kept in some receptacle so that the insects that emerge from them can be observed and collected, a most miscellaneous assemblage will in all probability be obtained. If the particulars of one such

collection be given, it will suffice to show how greatly these marble galls are appreciated by various kinds of insects. The collection in question was made in the winter of 1878–9 by Mr. W. P. Weston, and it included six species of small moths, all belonging to the group *Tortrices*, the caterpillars of some of which we have lately had under examination, seven different kinds of beetles, and no less than thirty species of Hymenoptera, including sawflies, gall flies, ichneumon flies, chalcids, ruby-tails, mason wasps, and other burrowing Hymenoptera, and finally bees. We may briefly consider what was the connection between these various insects and the galls.

In many cases, no doubt, it was simply a matter of hibernation. The damaged galls especially would form excellent retreats for all sorts of insects, provided their size were not an obstacle. This would certainly explain the presence of the beetles at least. Then, again, the galls in their younger condition, when they are soft and juicy, would no doubt be as attractive as an article of diet to some other plant-eating larvæ as they are to those of the gall-flies themselves, and such larvæ would therefore frequent them for food. This was certainly the case with at least one of the moths, which is regularly an inhabitant and devourer of galls. Other caterpillars, again, might use the damaged gall as a retreat during pupahood. The presence of the saw-flies would probably be explained in this way. The ichneumons were of course parasitic on the moths and saw-flies, the chalcids on the gall-flies. The burrowing Hymenoptera, many of which tunnel in wood, had apparently selected the galls for their burrows, and they, again, would bring their parasites with them, which would account for the presence of the splendid little ruby-tail, whose habits are in accordance with this supposition. The bees were a very minute species belonging to a group which make their nests in all sorts of localities, such as the hollow stems of plants like brambles or docks, the deserted burrows of other insects, holes in stones and cracks in walls, and, evidently, we may add in galls also. Thus we have seen that when a *Cynips Kollari* makes a puncture in an oak bud and lays an egg there, she is performing an act which may have consequences of the most varied character, and may benefit not only her own offspring but hosts of other creatures as well. And what is true of this particular kind of gall applies no doubt, with modifications, to other species in like manner.

(*To be continued.*)

THE TREE CREEPER.

By HARRY F. WITHERBY.

THE tree creeper (*Certhia familiaris*) is the smallest of our true climbing birds, measuring only five inches in length.

The species is distributed generally over England, and although migratory in other countries, it remains with us all the year round.

On account of its unpretending habits and its general colouring, which assimilates itself to the natural haunts of the bird, the creeper is not often seen, and consequently it is usually considered to be more rare than it really is. The tree creeper is very sombre in colour. The back and head are dark brown streaked with greyish brown, the wings are the same in ground colour, but have several bars of greyish white running across them. The tail is reddish brown, and the centre of each feather is of a dull white. The chin, throat, and belly are of a silvery white, often soiled by the bird's contact with the tree.

Tree Creepers on an Oak Tree containing their Nest.

The favourite resorts of this bird are wooded districts and the larger kinds of trees. It is especially fond of localities in which there are a number of trees grouped together, such as an avenue of trees, so that it can move from one to another without interruption. It is a very solitary bird, and is either seen alone or in pairs, but never in large numbers.

The manner of its climbing is different from that of all other birds of its family. The creeper almost invariably commences to climb at the bottom or very near to the bottom of the tree, and it then proceeds upwards in a spiral direction, winding its way round and round the trunk, searching for insects in every possible crevice. Arrived at the top it seldom flies to a different part of the same tree, but goes to the base of another and repeats the same operation. It is an exceedingly active little bird, and when seen is usually thus employed, seldom being at rest in the daytime.

The creeper climbs by making a number of quick movements—so rapid are they that if the bird is not carefully watched it seems to be gliding evenly up the trunk; hence, no doubt, its name, which is apparently a misnomer, for it is really a tree climber.

It climbs in its neat way by means of its claws and tail. The claws are long and curved, three pointing forwards and one backwards, and with these the bird obtains a secure hold on the tree. The feathers of the tail are stiff and pointed, and the tail itself curving downwards when

XUM

SOUTH.

WEST. EAST.

PHOTOGRAPH OF THE CENTRAL PORTION OF THE MOON WHEN 136 HOURS OLD.

Taken by MM. PAUL and PROSPER HENRY, with their 13-inch refractor, at the Paris Observatory, on the 23rd March, 1893. The sensitive plate was placed behind an eye-piece which enlarged the image in the principal focus sixteen times.

XUM

XUM

XUM

the bird is upon the tree, is invariably kept touching the bark, never being lifted from it.

The tree creeper is very shy, and rarely allows itself to be seen for any length of time; for although it does not seem to be watching, it quickly places itself on the side of the tree furthest from the observer.

Unlike the nuthatch, the creeper does not, as a rule, descend a tree, and on no occasion does it descend head foremost. I have, however, seen one, while in the act of pulling out a piece of touchwood from an old oak, take several steps backwards.

The flight of this bird is undulating, and is generally confined to short journeys from one tree to another. It utters a small, high-pitched note, often repeated, resembling the syllable "twee."

The food of the tree creeper is composed of small beetles, larvæ, spiders, and other insects, which infest the bark of trees.

The beak is about as long as the head, and, being curved and slender, can be thrust into the crevices of the bark to extract the lurking insect. It is not formed for tapping the tree like those of the woodpecker and nuthatch, and is never used for this purpose.

On account of the shape of its beak, together with its arched back and tail, the tree creeper, when seen from the side, assumes in general outline almost the form of a semicircle.

The nesting habits of this species are interesting. They sometimes build in a hole of a tree, but more usually between the bark and trunk of a decaying tree, where the bark has slightly parted from the trunk and forms a narrow crevice. The birds creep into this crevice, which is often not more than half an inch in width, and build their nest in it. One would suppose that the nest would be fixed to the tree itself, but such is not the case, for if the bark be taken off, the nest will adhere to it.

The nest itself is a handsome structure composed of fine twigs, grass, and chips of touchwood built in layers one on the top of another. It is lined with wool and feathers, and varies in size and shape according to the crevice or hole in which it is built.

The tree creeper usually has two broods in the year and lays from six to eight eggs at the first, in the month of April. It seldom lays more than five eggs at the second brood. The eggs are white with a few red spots, which are sometimes confined to the thick end of the eggs. They are almost identical in size and colour to those of the great tit (*Parus major*).

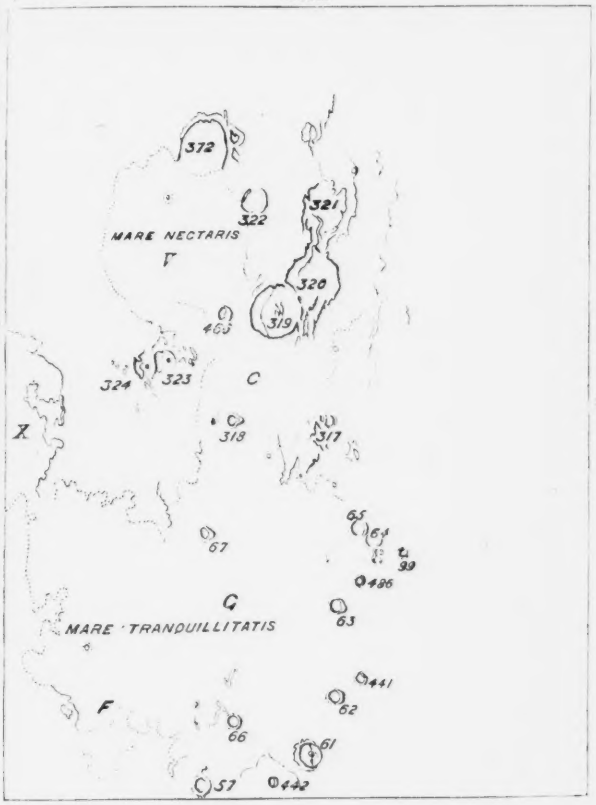
Both birds take their turn at sitting, and the young are hatched in about thirteen days. The birds sit very closely and may even be caught on the nest.

THE GREAT PLAINS ON THE MOON.

By A. C. RANYARD.

THE plate which illustrates this article has been made from a very beautiful photograph given me by Messrs. Paul and Prosper Henry, for the use of the readers of KNOWLEDGE. The photograph was taken on the evening of the 23rd of March, 1893, when the air was exceptionally steady—a condition which seems to be of far more importance for successful lunar photography than mere clearness of the atmosphere. It will be noticed that most of the *chefs-d'œuvre* of the Brothers Henry in lunar photography have been obtained in the months of March and May, during the evening hours when the new moon has a considerable altitude above the horizon. The station from which these beautiful photographs of the moon were obtained is in the grounds of the Paris Observatory, which is now surrounded by houses and factories, that give rise to a good deal of smoke, which generally lies within a few hundred feet of the ground, and is very recognizable from the grounds of the Observatory, but it is still more strikingly visible, even on a clear day, from the top of the Eiffel Tower, where it may be seen as a whitish, hazy canopy hanging over Paris and its outskirts. It seems that the best photographs of the lunar details are obtained when the rays of the moon plunge most perpendicularly through this hazy screen—and that the screen adds to the steadiness of vision, for such sharp photographs have not been obtained during the morning hours when the canopy of smoke has been partly rolled away by the night winds.

Some of the best photographs taken by the Brothers Henry show remarkable details in the lunar plains, indicating the existence of partly submerged craters and low-lying ridges, which hardly throw any shadow even when



INDEX MAP.

C. Mare Frigoris.	66. Jansen.	322. Beaumont.
F. Palus Somnii.	67. Maskelyne.	323. Isidorus.
X. Mare Fœcunditatis.	68. Mt. Hæmus.	324. Capella.
57. Vitruvius.	99. Dionysius.	371. Fracastorius.
61. Plinius.	317. Hypatia.	441. Maclear.
62. Ross.	318. Torricelli.	441. Dawes.
63. Arago.	319. Theophilus.	466. Mädler.
64. Ritter.	320. Cyrillus.	486. Manners.
65. Sabine.	321. Catharina.	

the sun is rising upon the lunar landscape. They are, probably, not due to mere differences of coloration in the lunar surface, for they are lost sight of as the sun rises; while the bright streaks radiating from some of the lunar

volcanoes, and other markings evidently due to differences of albedo, remain visible when the sun is at all altitudes.

One of the most remarkable of these veiled crater forms is traceable in the photograph on the Mare Tranquillitatis, a little to the west of the craters Arago (63) and Manners (486). In the photograph of the Messrs. Henry it is distinctly seen to be a double crater, surrounded by streaks or ridges which radiate from it. One of these, a double ridge, is well shown in our plate, trending up towards the circular crater Sabine (65). Though these ridges are not very lofty, they extend over an area which is very extensive compared with any of the volcanic areas on the earth. Thus the circular crater Theophilus (319) is stated by the Rev. T. W. Webb to be 64 miles in diameter—that is, it about corresponds in area to the county of Devon. The shallow or submerged crater on the Mare Tranquillitatis is nearly as large as Theophilus, and the ridges or lava streams which radiate from it extend over an area as large as Ireland.

In many instances we are able to determine the order in which lunar formations have made their appearance. Thus, Fracastorius (372), the great crater to the south of the Mare Nectaris, was evidently formed before the Mare Nectaris, or, at all events, before an overflow of matter from the Mare Nectaris broke into and partially obliterated the northern part of the ring about Fracastorius. It will be noticed, however, that the northern arc of the Fracastorius ring is still traceable, though it has evidently been much reduced in height by the matter which has overflowed from the Mare Nectaris. This is by no means a solitary instance; there are many other such partially obliterated rings upon the moon, indeed there are several traceable upon our plate—see the two half rings to the west of Maskelyne (57), and the incomplete large crater in the northern part of the Palus Somnii (F). The crater Jansen (66) seems also to have been partly broken in upon on its south-eastern side, that half of the ring being decidedly less lofty than the north-western half. There is also a partly obliterated large ring or polygonal area around Torricelli (318) in the Mare Frigoris, which seems to have been filled up with liquid matter, for the area within it is much smoother than the surrounding parts of the Mare Frigoris. The northern part of the outline of this area is more obliterated than the southern, as if the matter which filled up the crater had flowed into it from the direction of the Mare Tranquillitatis. On the other hand, the polygonal area may correspond to an overflow of matter from Torricelli (318) or to a crater which has been filled up by matter welling up from its own central orifice; but, if so, the polygonal crater must have been a mere depression without a surrounding wall. These partly obliterated crater forms, as well as the broken ring about Fracastorius (372), seem to point to the partial levelling of mountain forms by the action of a liquid which did not sweep away the ridges altogether and silt up the interiors of the craters, leaving no vestige of the previous formations, as might be expected if the obliterating action were due to water and the sediment deposited by water, but the submergence of the lunar formations seems to have been only partial, leaving relics of the previous formations which are clearly traceable on the new surface.

The theory that the lunar plains were formed by an outpouring of lava over an enormous area of the moon's surface would refer back their origin to a very early period in the moon's history, and the date of the formation of the craters invaded or partially obliterated by the lunar plains would be carried back to a still earlier period. It will be noted that these earlier craters do not present a distinctively rounded appearance indicating a longer period of weathering, or any obvious characteristics which differentiate them in a striking manner from craters formed upon these lunar plains, of which there are many visible in our plate, ranging in size from the most minute cup-shaped depressions up to craters of the size of Plinius (61) and Arago (63).

There are also to be seen, standing upon the lunar plains, many walls and detached masses which one would not at first sight recognize as having a volcanic origin, unless they correspond on a gigantic scale to the fumaroles which are occasionally built up on terrestrial lava lakes. One of the most curious of these forms will be recognized on the photograph to the south of Jansen (66). It seems to consist of two walls which meet at an acute angle. It is very white, compared with the general tint of the Mare Tranquillitatis surrounding it, and from near the southernmost end of the longer branch a series of isolated masses are arranged in a line which trends off towards the south-east. There is another curious white wall standing out upon the plain between the Mare Tranquillitatis and the Mare Frigoris. It is a little to the west of the promontory which lies to the north-west of Hypatia (317), and a little further west of this is a curious bent wall, the northern and southern parts of which meet at an obtuse angle. They may possibly have formed the western boundary of a polygonal submerged crater somewhat similar to that around Torricelli, for there are traces of a southern wall joining up the southern end of the bent wall with a small craterlet on the edge of the rising ground to the west of Hypatia.

Stretching from the southern end of the white promontory to the south-west of Hypatia is a curious narrow dark line, which seems not to be due to any photographic defect. It skirts the high ground on the edge of the mare for a distance of more than a hundred miles, and ultimately seems to pass through or over a ridge to the south of Sabine (65). In connection with this dark line, I would call attention to a comparatively narrow dark marking which skirts the western edge of the Mare Nectaris. It is somewhat broader than the dark line on the edge of the Mare Tranquillitatis, but it seems to skirt the high ground in a somewhat similar manner.

Notice of Book.

An Account of British Flies (Diptera). Vol. I. By F. V. Theobald, B.A., F.E.S. (Elliot Stock).—Of this new venture, the introductory part of which we noticed at the time of its publication, the author has now completed his first volume. Thus far, six families have been dealt with, comprising chiefly the fleas and most of the so-called gnats. Mr. Theobald's subject in the present volume is in many respects a tempting one. The chief drawbacks the student has to encounter are the extreme fragility of the perfect insects, and the obscurity of their colours and forms. In fact, they do not look interesting, and this circumstance, coupled with the difficulty of their preservation, has no doubt acted largely as a bar to their systematic study in this country, so that probably at the present moment there are very few people to whom the group is other than a neglected one. And yet it has very much to recommend it. It would be difficult to find in any other order of insects six consecutive families which exhibit so great a variety of habits, or such remarkable diversities of life-history. Some of the species, moreover, are associated with extremely interesting biological problems, and amongst them are to be found several which have an immense influence on man and his works and ways. It

is often the case that the most insignificant and uninteresting-looking insects are just those that have the profoundest influence on the world around them, and are the most concerned in adjusting the relations between organic and inorganic nature. Few better exemplifications of this could be found than in these apparently uninteresting and fragile flies. Thoughts such as these, of the great variety of insect life and the wide-reaching power of little things, constantly rise before the mind as one reads this account of the first half of the British Nematocera, or "thread-horned flies." Thus, in the fleas, we have excellent instances of the animal parasite and all the annoyances occasioned by such habits; and yet the parasitism is imperfect, the insects living upon the blood of their victims only in their adult condition, while in their larval stage they are non-parasitic, and subsist on solid animal matters. Their wingless condition, too, no doubt connected with their parasitic habits, cannot but excite interest and stimulate speculation. In the next family we get into totally different surroundings. There we find the gall-gnats, which are associated with the vegetable world, and imitate the habits of the hymenopterous *Cynipidæ* by forming excrescences, beautiful or disfiguring, on various plants, and more or less interfere with their economy, by arresting their growth or rendering their reproductive function abortive. Amongst these are not merely the little gnats that produce the hairy galls so common on nettles, the rose-shaped galls on willows, the tufts on white-thorn branches, the swellings on the stems of aspen leaves, and many other more or less harmless monstrosities, but also such serious pests as the wheat midge and the notorious Hessian fly, which are so destructive to cereals. Amongst this same group, also, we find that most remarkable of phenomena, asexual generation, and that, too, not merely by an unfertilized adult, but even by a larva, the stage which is usually totally unconnected with the functions of reproduction. In the fungus gnats, so called from the food of the larvæ, we have the remarkable and utterly unexplained phenomenon of the migration of vast hosts of the maggot-like larvæ in one continuous line "from twelve to fourteen feet in length, two or three inches broad, and half an inch thick, containing countless numbers, as close together as they can be packed." To this long worm-like composite body, which looks like a thin grey snake slowly working its way over the ground at the rate of something under an inch per minute, has been given the name of "army-worm." In the *Bibionidæ* we have the so-called fever-fly, which does damage to the hop-gardens, as well as the black, sluggish, sprawling flies that often appear in countless numbers in our streets for a few days in spring or early summer, and then vanish as suddenly as they appeared. Perhaps the best known of these are the St. Mark's and St. John's flies, named from the regularity of their appearance about the time of the days sacred to those saints in the calendar. In the *Simulidæ*, or sandflies, we pass into quite other surroundings again; for here we come across small flies which persecute man and beast after the fashion of mosquitoes. Here, too, we are introduced to the curious phenomenon of the assembling of the male flies in large numbers, to fly in circles round and round and execute the airy "dances" which are so fascinating to watch. And lastly, amongst the *Chironomidæ*, or midges, another set of dancers, we have the frequent inhabitants of the water-butt, the red, wriggling, aquatic larvæ called "bloodworms," which are incipient house builders, inhabiting, during their moments of leisure, tubes of their own construction at the bottom of the water. Their beautifully plumed locomotive pupæ, which are such familiar objects in ponds in spring, are still more attractive, and nothing can be more beautiful than the delicate tracery of their cast skins as they float at the surface of the pond with their exquisite white rosettes of breathing hairs. This again is a group which, like the gall-gnats, has got into irregularities over their reproductive processes, and exhibits the phenomenon of parthenogenesis. We have, perhaps, said enough to show that this volume deals with subjects of much and varied interest, and to induce some to follow Mr. Theobald's guidance in undertaking the study of the group. Very much yet remains to be done before anything like finality is reached in our knowledge of British gnats, so that there are abundant prospects of reward in the discovery of new facts to anyone who has the time and patience to devote to what, it must be confessed, is a somewhat intricate study. A copious bibliography has been added for the benefit of the earnest student, and there are a number of illustrations explanatory of structural and anatomical points, as well as showing typical species. A little more care might usefully have been expended on "editing." There is a list of errata, but this might have been considerably augmented, there being many misprints not recognized therein, especially in the scientific names.

Science Notes.

Sir Joseph Hooker is publishing, with the aid of the staff of the Herbarium at Kew, an index to the names of all flowering plants. It will be published in four quarto volumes, and will be entitled "The Index Kewensis." Sir Joseph, in giving an account of the origin of this important work, says: "Shortly before his death Mr. Darwin informed me of his intention to devote a considerable sum in aid or furtherance of some work of utility to biological science; and to provide for its completion, should this not be accomplished during his lifetime. He further informed me that the difficulties he had experienced in accurately designating the many plants which he had studied, and ascertaining their native countries, had suggested to him the compilation of an index to the names and authorities of all known flowering plants and their countries, as a work of supreme importance to students of systematic and geographical botany, and to horticulturists, and as a fitting object of the fulfilment of his intentions. I have only to add that, at his request, I undertook to direct and supervise such a work."

In a recent number of the *Kew Bulletin* we have a remarkable illustration of the influence of mankind upon local climates. In Africa, the country between the Nile and the Red Sea is notable for its general barrenness. But the present condition of things has probably been brought about by human agency. In fact, this is largely proved by the names of localities. Thus, the Arabic names of the valleys are those denoting the names of trees, although now not a single tree is to be met with. It is suggested that the Arab and his camel have been the means of converting a wooded country into a waste. The camels eat the leaves and shoots of the trees, and the Arabs have burned the trees for charcoal.

At the Royal Society *soirée* on the 7th June, Captain McEnvoy exhibited the hydrophone, which, in connection with a new instrument named a kinesiscope, is intended to be used at night, or in foggy weather. It has for its object the prevention of surprise attacks from torpedo boats, or other hostile vessels approaching. It will give

warning of their movements when they are several miles distant, by ringing bells, flashing lights, &c. It may also be employed to warn vessels off dangerous points of the coast. Lord Kelvin exhibited illustrations of the molecular tactics of crystals, and Prof. H. G. Seeley exhibited fossil skulls from the Karoo rocks, Cape Colony.

One of the simplest methods by which micro-organisms can be removed from water is by the addition of alum. Experiments carried out at Leeds a few years ago showed that the addition of one-half a grain of alum to a gallon of water reduced the number of microbes by ninety-nine per cent., and the material has recently been used for purifying water on a large scale in America. It is found that in all cases after agitating water to which a small amount of alum has been added, an absolutely sterile liquid is obtained, though as many as 1200 microbes originally existed in a cubic centimetre (0·06 cubic inches).

At the Royal Society *soirée* on May 10th, Prof. Marshall Ward lectured upon his experiments on the action of light on the spores of bacteria and fungi. He has proved that solar and electric light rapidly kills such spores; hence "sweetness and light" were very appropriately coupled together by Matthew Arnold. The destruction of the spores seems to be a direct action of light, and not due to elevation of temperature, or to any indirect poisoning or starving process incident on changes in the food materials. By exposing parts of the same culture of the anthrax bacillus behind screens transmitting blue and violet rays, and behind screens which cut off those rays, it was found that the bactericidal action is almost entirely confined to light of high refrangibility. From observations of plants, it appears that the part of the chlorophyll which absorbs the blue-violet rays is a screen to prevent the destruction of easily oxidizable bodies as they are formed in the chloroplasts; indeed, Prof. Ward concludes that the colours of spores, pollen grains, &c., are of the nature of colour-screens, preventing the passage of those light-rays which would destroy reserve substances in the plant by promoting their rapid oxidation.

We recently referred to the scheme now in progress for obtaining motive power from the Niagara Falls. Mr. A. B. H. Thwaite has a plan for the distribution of electric power over a considerable portion of England. His idea is to burn the fuel at the mines, where it costs but little, and then to transmit the power resulting from the combustion of the coal (and gas) by high pressure alternating currents. He proposes to use gas engines of not more than 500 horse power to generate the currents. From one station he would supply the centres of industry of Lancashire and the area adjoining the Ship Canal; from a second, those of Yorkshire; from a third, those of the Midlands and London. This is a great scheme, but experiments might be made on a small scale in order to test its advantages.

Mr. Norman Lockyer writes in *Nature* of May 18th on "The Early Temple and Pyramid Builders." In his previous articles on Egyptian astronomy he has shown that it is possible to divide Egyptian temples into solar and stellar temples. In the present paper he states that the worship of the bull, Apis, preceded the building of the pyramids. The sun at the vernal equinox 4500 B.C. was in the constellation Taurus. Biot has shown that the equinox occurred with the sun near the Pleiades in 3285 B.C.

If all the rain that falls in a year were spread evenly over the surface upon which it was precipitated, the average depth of water in the area drained by the Thames would be twenty-eight inches. Compare this with the following remarkable diurnal rainfalls described by Mr. Clement L. Wragge, as occurring at Crohamhurst, on the western slope of Mount Blanc, in South-Eastern Queensland:—For 24 hours, ending 9 a.m. February 1st, 10·775 inches; ditto, February 2nd, 20·056 inches; ditto, February 3rd, 35·714 inches; ditto, February 4th, 10·760 inches. The rainfall of February 3rd is certainly one of the highest ever recorded, though it has been exceeded on the Khasi Hills of Bengal.

An Indian gazette gives an account of the protective effect of certain colours against the sun's rays. It is urged that no one has ever been a victim to sunstroke or sun fever through a dark source of heat, and it is asserted that the chemical rays do the mischief. A correspondent writes to say that he has had all the linings of his hats and coats made of yellow material, with the satisfactory result that after a trial of five years (often under circumstances of extreme exposure) he has had no return of either fever or sunstroke, to both of which he declares that he was previously a frequent victim.

Extremely useful high-temperature thermometers have been constructed by Messrs. Baly and Chorley by replacing mercury with an alloy of sodium and potassium, which is liquid at ordinary temperatures and remains so through a long range. When a very hard glass is employed to hold the liquid alloy, it becomes possible to determine directly the temperature of any source of heat up to 1150° Fahr.

Natural Science for June gives a translation of a paper by S. Carl Berg, from the *Anales de la Sociedad Científica Argentina* of November, 1892, in which the author describes cases of cannibalism among insects, which he has himself observed. The most voracious of the Noctuids, he says, is the caterpillar of *Heliothis armiger*; a single one of these consumed in twenty-four hours six or seven other caterpillars. Hitherto cannibalism among crickets has been noticed only among captives, but the author records a case among locusts in the free state. This was in the drought of 1883, in the Banda Oriental. He says, "I saw different attacks, in which the conquerors, two or three at a time, got hold of the weaker members of their own kind, throwing them over, and opening the abdomen in order to devour the entrails, these being the softer and more savoury portions, since they contained some of the vegetable food."

At a recent meeting of the Anthropological Institute, Dr. E. B. Tylor exhibited a collection of the stone implements of the Tasmanians, which are unground (*palæolithic*). Rough flakes of chert or mudstone, edged by chipping one stone with another, and grasped in the hand without any handle, they serve the purposes of notching trees for climbing, cutting up game, and scraping spears and clubs. The Tasmanians seem to have kept up this rudimentary art until the present century; and perhaps their state of civilization may throw some light on that of the palæolithic age in Europe.

Professor Dewar, at a recent Royal Institution lecture, showed an air barometer which could measure differences of pressure in a column of air as small as one-millionth of an atmosphere. With a water barometer, which is thirteen times more sensitive than a mercury barometer, such a difference could not even be detected.

A discussion by Lieutenant-General Strachey, of the daily curves of temperature made at Greenwich Observatory for twenty years, shows that the time of afternoon mean temperature throughout the year is a little before or after 7 p.m. In the summer the time of absolute minimum is between the hours of 3 a.m. and 6 a.m. Sunrise in December is about an hour and a half before the time of mean temperature; while in June it is more than four hours earlier. In the former month sunset is rather more than three hours before the time of mean afternoon temperature, and in the latter it is about half an hour after that time.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

To the Editor of KNOWLEDGE.

DEAR SIR,—To designate the point nearest to the sun of a planet's orbit the word "perihelion" is used. Similarly for the moon the word "perigee," for a star the word "periastron," and for one of Jupiter's satellites the hybrid word "perijove." I do not know what the proper words are in the cases of the satellites of Mars, Saturn, Uranus, and Neptune. Would it not be better, and more convenient, to have one word which could be used in every case; say, some word derived from the Greek meaning "nearest to the focus"? I have forgotten (if I ever knew) the Greek for focus, but I suppose there is some word. In default of a word for focus, "pericentre" (*κέντρον*) might be used; "centre," of course, being used in the sense of centre of force. Can you suggest a word?

Yours truly,

4th June. J. R. HOLT.

To the Editor of KNOWLEDGE.

DEAR SIR,—Would you kindly correct, in the next number, the following mistakes which have been made, mostly in the printing of the tables:—

Page 115, second column, line 34, instead of "Bradley-Draper," read "B. D. (Bonner Durchmustering)."

Page 117, Table 9 is incomplete; add—

Limits in δ.	Limits in α.	Q.	n.
+ 20° to + 60°	$22^h\,42^m - 3^h\,29^m$	1·43	57·7
,,	3·29 — 8·15	0·90	31·7
,,	8·15 — 13·25	0·64	42·7
,,	13·25 — 17·59	0·71	55·8
,,	17·59 — 22·42	1·07	48·4
+ 60 to + 90°	0·0 — 24·0	1·64	47·5

Page 118, Table 11 is omitted. Read—

Result for the mean value of $\tau = 0''082$—
230 Stars of Type I. gave $q = +0''062$.
338 ,, Type II. ,, $q = +0''074$.

Page 118, second column, line 7, instead of "mean mag. 3·6," read "3·9."

Page 118, Table 12, the letters τ and μ to be interchanged.

Page 118, second column footnote, add these words—"The necessity of a correction of the constant of precession, alluded to before, is evident from the values of τ in this table."

By making these corrections, you will oblige,

Yours sincerely,

Groningen, 3rd June, 1893. J. C. KAPTEYN.

To the Editor of KNOWLEDGE.

SIR,—Mr. Monck expresses a doubt in his letter on "Sirian and Solar Stars," in your June issue, as to the continuous diminution in the proportion of Sirian stars as we pass outwards from the plane of the Galaxy toward the galactic poles, such as would result from a continuous diminution in photographic brightness, found by Prof. Kapteyn.

Without identifying myself with Prof. Kapteyn's position, I may state as a simple fact that such a diminution in the proportion of Sirian stars in passing from the Galaxy to its poles does not occur; but that a diminution does take place as we move from a zone included between 30° S. galactic latitude and the southern edge of the Galaxy in the direction of the galactic poles. The following table shows the position:—

Class.	N.G.P.-70°.	70°-50°.	50°-30°.	30° to N. edge of Galaxy.	S. edge of Galaxy to 30°.	30°-50°.	50°-70°.	70°-S.G.P.
AB	55·5	65·1	51·9	64·3	69·8	74·6	58·0	48·6	50·0
EFG	20·2	12·7	18·7	15·6	15·8	11·2	20·6	24·6	18·4
HIK	21·8	20·6	26·4	18·8	12·4	13·4	19·1	24·0	30·0

The above table I formed last summer when constructing charts of the Draper catalogue stars, described in the paper "On the Distribution of Stellar Types in Space" (*Astronomy and Astro-Physics*, January, 1893), in which the stars were inserted according to spectrum; and the set from which the above proportions are taken excludes all stars the "observed brightness" of whose spectra falls below 6·5 on a scale of 4·0 = bright, 8·0 = faint, adopted by Pickering, 6·5 being the limit at which the spectrum of the star could be deciphered reliably.

The region recognized as the Galaxy is that of Proctor's Atlas.

As Pickering's galactic divisions "M" (*Annals Harv. Col. Obs.*, Vol. xxvi., Table xli.) include 2804 stars against 1208 present in the Galaxy of Proctor's Atlas, the fact that his percentages are

A	F	E G	H I K
·63	·11	·05	·16

against my

A	F	E G	H I K
·662	·112	·046	·124

shows that the extension on each side of the Galaxy brings a diminution in the proportion of Sirians for "observed brightness" 6·5, as compared with the more limited area of the Galaxy used by me. The theory of galactic condensation derives no support from the extension of the galactic area, as Mr. Monck supposed.

The following table for stellar magnitude down to 5·99 (*Harv. Photom.*) brings me into strict line with Mr. Monck's argument, who is working at that limit:—

Class.	N.G.P.-70°.	70°-50°.	50°-30°.	30° to N. edge of Galaxy.	S. edge of Galaxy to 30°.	30°-50°.	50°-70°.	70°-S.G.P.
AB	63·0	70·0	60·0	69·7	70·7	80·8	63·0	54·0	50·0
EFG	33·0	17·0	15·1	11·2	14·4	8·1	9·8	23·0	19·0
HIK	4·0	12·0	22·4	17·0	11·1	8·5	19·6	23·0	19·0
	24	71	152	224	270	270	112	69	16

=1208 stars.

The first table, however, furnishes a more satisfactory induction, considering that the number of stars employed is almost four times as great, and we have Prof. Pickering's assurance of the reliability of the spectrum-reading at the limit of "observed brightness" used.

It will be seen that the diminution is not "continuous," nor could it well be expected to be so, for the condensation of Sirian stars about the Galaxy does not conform with any symmetry to the lie of the galactic plane, not to speak of extra-galactic condensations of a thoroughly local, though extensive nature. In fact, comparison of the contents of zones upon galactic co-ordinates, where the contents are so unevenly distributed along the zone, as they are for the stars of the Draper catalogue, can only serve to level the inequalities of distribution which it is the set purpose of such comparisons to detect.

There is a zone to which the main line of condensation of Sirians conforms, and that zone is the great belt of bright stars. This accounts for the fact that the axis of

XUM

condensation in the rich Sirian region (Puppis) Canis, Orion, Taurus, lies off the southern border of the Galaxy before cutting through it in Perseus and Cassiopœia, whilst after that point the whole mass of Sirian condensation passes north of the southern edge of the Galaxy, from which it recedes further northward as we descend through Cepheus, Cygnus, Lyra, Hercules, and Ophiuchus to Scorpio, the southern limit of the Draper catalogue. There is not a doubt that the completion of the Harvard spectroscopic survey will show the main line of Sirian condensation to be coincident with the great belt throughout its course.

Mr. Monck says that Solars seem to preponderate in Sobieski's Shield. As may be seen from the curves of distribution published with the paper mentioned, there is a very decided preponderance of Solars in this region, and, as I remarked at the time, this is the only point where the Solars gain supremacy over the Sirians in the Galaxy, a fact more remarkable still when it is remembered that this rich solar group, unique in its nature, lies immediately off the break, equally unique, which occurs in the great belt of bright stars in its passage through Ophiuchus. If this break be not physical, then it can be optically produced only by the proximity of the sun to the great belt at this point, causing an apparent dispersion of its constituent stars; and this solar group, I feel sure, is in some way involved. I am, Sir, yours faithfully,

Stretford, Lancashire, J. MACLAIR BORASTON.
June 6th, 1893.

To the Editor of KNOWLEDGE.

Groningen, 12th June, 1893.

DEAR SIR,—Will you allow me some space to say a couple of words in answer to some remarks made by Mr. Monck in the April and June numbers of KNOWLEDGE.

In the first, he remarks that it seems as if the diminishing of the difference between the photometric and photographic magnitudes, as we pass outward from the Galaxy, might be explained by systematic error in the eye estimations of the stars in the Galaxy.

To a great extent this must doubtless be conceded. It can only be called in question if the *direction* and the *amount* of this systematic error, as determined by photometric methods, proves sufficient to explain the divergencies found. My discussion of the whole matter has been published in the "Bull. du Com. intern. pour l'exécut. photogr. de la Carte du Ciel," tome II. (1892).

In consulting this publication Mr. Monck will find that I carefully considered this point, with the result that, as the photometric observations as yet published seem to make it inadmissible to attribute to the error in question a value exceeding 0·2 m. or 0·3 m., this error is insufficient to cover the facts.

In regard to the letter inserted in the June number, I may say at once that I am fully aware of the fact that several points investigated by myself, in respect to the distribution of stars in space, have been independently suggested by Mr. Monck, and I feel very happy to find our results in general mutually confirmed. This extends to the remark made by him about the distinction to be drawn between Capellan and Arcturian stars. Though I was led to this same conclusion, even at the time of my first publication, I have not as yet published anything about it because I hoped to be able shortly to investigate a far greater number of stars, and especially because Prof. Pickering's sub-classes are less trustworthy and to a large extent dependent on the magnitude. Now that attention has been called to the fact it may be well to state the rude results arrived at.

Of 374 stars of the 2nd type with proper motions exceeding 0″16 (Stumpe's stars)

40 per cent. belong to Pickering's class F
18 „ „ „ „ „ G
42 „ „ „ „ „ K

Prof. Pickering finds for *all* his stars (without regard to proper motion)

22 per cent. belonging to class F
26 „ „ „ „ G
52 „ „ „ „ K

So that, of the stars of the 2nd type, those of the class F seem to be especially condensed about the sun.

I feel less inclined to agree with Mr. Monck about the question of the equality of the absolute velocity of the 1st and 2nd type stars, and I think he exaggerates our ignorance on this point. I feel somewhat confident that, after having carefully considered the proof of my Prop. X. in the June number, he will agree with Miss Clerke that it is difficult to contest, in the present state of knowledge, the conclusion that stellar rates of travel are independent of spectral distinction.

In conclusion, I may perhaps be allowed to state more clearly than I have perhaps done as yet, that my paper on the systematic difference of photographic and visual magnitudes in various parts of the sky, as well as those on the distribution of stars in space, are to be considered as *provisional* only—several points require a more exhaustive research, partly to be based on yet more extensive materials.

Especially the question, "Is it true that galactic and extra-galactic stars have equal linear velocities, and if not, in what proportion do they vary?" seems to call for a far more exhaustive investigation. Only the consideration that these investigations will take of necessity a very considerable time, has determined me in publishing results that cannot be considered as quite definitive.

Yours sincerely, J. C. KAPTEYN.

THE GOVERNMENTAL INQUIRY AND THE FIELD-VOLES.

By W. F. KIRBY, F.L.S., F.E.S., *Assistant in the Zoological Department, British Museum (Natural History), South Kensington.*

BLUE-BOOKS dealing with scientific subjects are more common now than formerly, and much information which will be useful both to naturalists and agriculturists has been brought together in a convenient form, in the recently published "Report of the Departmental Committee appointed by the Board of Agriculture to inquire into a plague of field-voles in Scotland, with minutes of evidence and appendices, and a copy of the minute appointing the Committee."

The field-voles are small animals resembling mice, which appear from time to time in enormous numbers in various countries, and cause very serious injury to the crops. During 1891 and 1892, the southern counties of Scotland have been devastated by the short-tailed field-vole, and, according to Mr. R. F. Dudgeon's estimates, drawn up early in 1892, "in Roxburghshire, 30,000 to 40,000 acres had been affected, of which he considered 12,000 to 15,000 acres had been rendered useless; in Dumfries-shire, 40,000 to 50,000 acres, and in the stewartry of Kirkcudbright, 10,000 to 12,000 acres were described by him as infested by voles."

So serious became the evil that a Committee of Inquiry was appointed by a minute dated the 28th May, 1892; and it is their report which has just been issued. In the spring of 1892, Dr. Loeffler, a German bacteriologist, announced that he had discovered a new bacillus, producing a disease

which he called "mouse-typhus," in mice and voles, when swallowed by them, but perfectly innocuous, so far as yet known, to all other animals. At this time the Plain of Larissa, in Thessaly, was suffering from a plague of voles, and Dr. Loeffler was invited by the Greek Government to apply his new method of destroying them in that country, which he afterwards claimed to have done with perfect success.

In January, 1893, Sir Herbert Eustace Maxwell, the Chairman of the Committee of Inquiry into the plague of voles in Scotland, and Mr. James Edmund Harting, Librarian of the Linnæan Society, and Secretary to the aforesaid Committee, proceeded to Greece to make inquiries on the spot into the practical success of Dr. Loeffler's method, and on its applicability to Scotland. Their verdict is one of "not proven." Yet the evidence adduced appears to show that the pest was noticeably diminished, and that the remedy was perfectly safe. The apathy of the natives is admitted, and although the infection is probably spread owing to healthy voles devouring their sick comrades, this is discredited, because it does not appear to have been observed among voles in a state of nature. Such a pest could not be stamped out without the remedy being applied thoroughly and on a large scale, for the voles in surrounding fields would soon overrun the fields which had been cleared of the pest. One large land-owner alone, M. Anastasiades, whose estate of 7500 acres had been cleared of the voles by Dr. Loeffler's method, expressed himself fully satisfied with the result. Is there any proof that if the same method had been honestly applied to other estates, the result would not have been equally satisfactory?

We are told that the peasants, both Christians and Mohammedans, look upon the pest as a visitation of God; and that the Mohammedans were about to send a ship to fetch "holy water" from Mecca to stay the calamity. This is not the spirit of persons who would give reliable evidence on the success or non-success of a scientific remedy.

Although Dr. Loeffler reports that Scottish voles are just as susceptible to the virus as other species, the Committee pronounce against his method for three different reasons.

FIRSTLY:—The expense (or estimated expense) would render it inapplicable to Scottish hill pastures.

SECONDLY:—"Mouse-typhus is not contagious; it can only be communicated to those animals that will swallow some of the virus. The allegation that healthy voles will become infected by devouring the bodies of the dead has not been satisfactorily proved. That Greek voles, when in captivity, have been observed to feed upon the corpses of their fellows, hardly warrants the assumption that Scottish voles, in a state of liberty, will do the same; and unless the disease were communicable from one animal to the other, it is not easy to see how the remedy could prove effective on extensive hill pastures."

Of course, unless the remedy could be applied universally, it would not exterminate the voles, or prevent immigration from adjoining districts; but it might materially reduce their numbers. As for the doubt that Scottish voles would devour their dead and dying fellows, it ought not to have been expressed in the absence of such an easy experiment, which in all probability Dr. Loeffler has already made. Why should not Scottish voles possess the cannibal propensities of other voles and mice? Even the common mouse will devour those of its own kind which it finds in spring traps, as every housewife must be aware.

THIRDLY:—"The fluid loses its value in about eight days after preparation; consequently much disappointment might ensue if, after a supply had been obtained, a fall of snow or wet weather were to interfere with its distribution over the land."

This statement is not clearly explained, but probably refers to fluid prepared in large quantities, and exposed to the air. There is no reason, that we are aware of, why virus enclosed in hermetically-sealed glass tubes should not preserve its infective properties for a much longer period. The rest of this objection simply indicates settled weather as the best time for making the experiment. It is clear that if a piece of ground, swarming with voles, was charged with infected bread, the voles would not wait so long as eight days to devour it, if they touched it at all.

The Committee practically confine themselves to advising "periodical and timely burning of grass and heather, followed by active pursuit of the vermin by men using wooden spades and dogs"; and they also advise the protection of owls and other natural enemies of the voles. But why did they not begin by obtaining a supply of the virus from Dr. Loeffler (especially as it is acknowledged to be quite harmless to all the larger animals at least), and experiment with it in Scotland on a small scale in the first instance, and then report on the results? Would it not have been more satisfactory to have done this before travelling to Greece to make inquiries through interpreters, obtain doubtful evidence, and then pronounce against a method which certainly appears to deserve a fair trial in Scotland, whether it was fairly tried in Thessaly or not!

CHEMISTRY AND CUISINE.

By VAUGHAN CORNISH, M.Sc., F.C.S.

THE male portion of mankind seldom inquire too closely as to the means by which its food has been prepared. Our diet, indeed, is so varied that it is not a very easy matter to find out what quantities of the necessary food-stuffs one has eaten during the day. It is, however, worth while to take the requisite trouble to find this out, more particularly for the numerous class of men of sedentary habits who often have the idea that they are over-eating themselves, and who are so frequently assured by anxious relatives that they "don't eat *half* enough."

The weight of food taken during the day may be most readily determined by using one of the spring balances employed for weighing letters and parcels. The plate or cup, with its charge of food, may be placed upon the disc of the letter-weighing balance, and after the experimenter has eaten all or such part as satisfies him, the plate or cup is again placed on the disc, and the difference of the two weighings is entered in a note book. With the spring balance the weight is read off at once on the dial, so that the weighing can be done sufficiently quickly not to let the food get cold.

Having thus conscientiously recorded the amount of food, solid and liquid, taken in a day, the next thing to do is to calculate out the amount of the various "food-stuffs" in the daily ration, and compare them with a standard ration such as may be found in a book on the chemistry of food. The daily ration required by a man depends upon the daily bodily waste, which, again, depends upon the weight and upon the amount of bodily work done.

The standard ration given below is calculated for an eleven stone man supposed to be taking moderate exercise. If hard bodily work is to be done, the amount of food containing starch and fat must be increased.

Though our foods are so varied, the different kinds of feeding materials or "food-stuffs" they contain are few,

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or at least for practical purposes may be reckoned under a few heads. Thus—

FOOD-STUFFS are—

1. Albuminoids and other substances containing nitrogen.
2. Fat, starch, and sugar.
3. Mineral substances, chiefly common salt and phosphates.
4. Water.
5. Food adjuncts.

The principal functions of the above classes of food-stuffs are as follows :—

1. Albuminoids, &c., are oxidized by the air which is inhaled into the body, and go to form the muscle and flesh. The process of oxidation gives out heat, and hence these *flesh-forming* foods assist also to keep up the heat of the body.

2. Fat, starch, and sugar are oxidized in the body, thereby acting as *heat givers*, but they do not form muscle and flesh. In hard bodily work it is necessary to increase the supply of heat-giving food. The waste of muscle and flesh does not increase with increased bodily labour in nearly the same proportion as does the demand upon the heat of the body. Fat has about $2\frac{1}{3}$ times the warming power of starch and sugar, there being a larger proportion of carbon and hydrogen to be oxidized. Hence fat is the principal food-stuff to be added to the diet to meet the demand of extra bodily work or the corresponding tax of a colder climate. Fat can be stored up in the body (as a layer under the skin), where it acts as a store of heat-giving material which can be drawn upon as required by the system.

3. Of the mineral substances taken into the body the lime salts and phosphates form the solid fabric of the bones.

4. Water constitutes about two-thirds by weight of the substances of the body. The water taken in as food is required both as a constituent of the body and also as a carrier of food in and through the system.

5. Food adjuncts are of importance more on account of their effects (whether stimulating or sedative) upon the nervous system and on account of their effect on the palate than for any actual power of nourishing or sustaining the fabric of the body. The most important are alcohol, and the alkaloids contained in tea, coffee, and cacao.

The daily ration of an adult under ordinary conditions, according to Prof. Church, should contain the different food-stuffs in *about* the following quantities :—

DAILY RATION.

1. Water . . .	88·66 oz.	avoirdupois
2. Albuminoids . .	4·25	,,
3. Starch and sugar .	11·40	,,
4. Fat . . .	3·77	,,
5. Mineral food . .	1·03	,,
	109·11	

The small quantity of food adjuncts is not included in the above table. The actual weight of food eaten will exceed the above total by about one ounce on account of fibrous material, either vegetable or animal, which is taken with the food, but which is not assimilated by the body. The food-stuffs 3 and 4 have the same function, viz., that of keeping up the heat of the body. Weight for weight, fat has about $2\frac{1}{3}$ times the heating power of starch. As starchy and fatty foods are to some extent interchangeable in diet, a convenient way of expressing the daily ration is to multiply the amount of fat by $2\frac{1}{3}$, which gives the quantity of starch equal to the fat in heat-giving value. In the above case the amount of fat is 3·77, which, multiplied by $2\frac{1}{3}$, gives 8·8, which, added to 11·40, the amount of starch and sugar, gives a total of 20·2 ounces of heat-giving food *reckoned as starch*. We may, therefore, write the daily ration thus—

Water.	Flesh-formers.	Heat-givers (reckoned as starch).	Minerals.
88·66	4·25	20·2	1·03

Let us now return to the practical calculation of the quantities of the food-stuffs contained in a day's diet, the weight of which we have supposed to be taken during meals by aid of the spring letter-balance. This may be done by setting out the results of the weighings in a tabular form as follows :—On the left, in the first vertical column, set down the names of the various foods eaten ; bread, butter, milk, &c. In column 2 set down opposite the names of the foods the weight of each which has been eaten during the day. In some work on the chemistry or the composition of foods find the percentage composition of the food eaten, and hence calculate the weight of each food-stuff in the several articles of food taken. Enter the water in vertical column number 3, the flesh-formers in column 4, the heat-formers in column 5, and the minerals in column 6. The vertical columns are then added up and we obtain at the foot of column 2 the total weight of food taken, and at the foot of the other columns the total weight of each food stuff. It then remains to compare the results obtained with the standard ration given above, or with some other ration suited to the particular nature of the daily employment of the person. Of course it is not only the quantity of the food-stuffs which has to be taken into account in judging whether the diet is a suitable one or not; we must also take account of the proportion between the amounts of the different food-stuffs. The most important ratio, the actual value of which should, however, depend upon the amount of bodily work done, is the ratio of flesh-formers to heat-givers. If the fat be calculated according to its "starch equivalent," the ratio should be about $1:4\frac{3}{4}$. The ratio of flesh-formers to heat-givers is termed the *nutrient ratio*, and a table of the nutrient ratio of different classes of food is a valuable guide in the determination of a diet. Such knowledge is absolutely necessary where a uniform diet has to be prescribed for persons who are not at liberty to select and vary their food according to their inclination, as, for instance, prisoners. Generally speaking, the flesh-forming foods containing nitrogen are the most expensive. Nitrogen, though so abundant in its uncombined and inert form in the air, generally becomes expensive when wanted for any useful purpose, whether as manure for the land or as food for man. How this curious fact comes about we hope to have another opportunity of explaining. The most important flesh-formers are the lean of meat and green vegetables. The starchy foods, as rice and potatoes, are generally speaking cheap and easily obtained. The fat of meat supplies the heat-givers in a more concentrated form, though not so cheaply. The form in which the various food-stuffs may be taken must depend largely upon the mode of life. Thus, a labouring man who works in the fields may make his dinner off a dish of cabbage and fat bacon, deriving the flesh-formers from the vegetable and the heat-givers from the animal food. For men of sedentary habits such a combination would be scarcely suitable. A lean chop with potatoes—a very usual luncheon for a business man—supplies the same food-stuffs in a lighter form. In this case the flesh-formers are derived from the animal food and the heat-givers from the vegetable. Needless to say, this is a more expensive meal than the first. Cheese is one of the cheapest forms of nitrogenous food, and may be taken as a substitute for lean meat.

The agricultural labourer is too poorly paid often to afford lean fresh meat, but the nature of his occupation enables him to consume a quantity of hard cheese such as would be impossible for persons engaged in the more highly paid but sedentary occupations.

The effect of *cooking* is, in the first place, to soften the food, and thus render it easier to masticate. The heat may be applied as dry heat as in roasting, or moist heat as in steaming, but in either case the large quantity of water which is contained in all foods makes the various processes of cooking largely a matter of steaming. This assists the softening of the fibres, &c. Another important change produced by the action of heat is the solidification of the albuminous material which forms so important a constituent of lean meat and of the other flesh-forming foods. The coagulation of the albumen is familiar to all in the process of boiling an egg, the boiling temperature being necessary in order that the white shall "set." The same setting of the albumen in meat occurs at the surface of the meat during the roasting of a joint. In this process, in which the object is not to extract but to retain all the goodness of the meat, a fierce heat is at first applied all round the surface of the joint. This solidifies the albumen near the surface of the joint. The joint is then moved rather further from the fire, and cooked at a somewhat lower temperature. A great deal of water evaporates from the meat, but most of the juices are confined in the joint by means of the bag or sack of coagulated albumen. If the joint were kept too near a hot fire after the first coating of coagulated albumen has been formed the coagulation would go on throughout the joint, and the meat would become hard and indigestible. When a well-cooked leg of mutton is cut it is full of juices, which flow out readily. If the joint had been put down before a slow fire, and at some distance from it, the water drawn out of the joint by the heat would have carried with it much of the juice and of the fat which should be kept in by the coagulated albumen. In those processes of cooking in which the object is to extract the juices from the meat, the coagulation of the albumen has to be avoided. In cooking starchy food, such as potatoes, the most important change produced by the heat is the swelling up and bursting of the starch granules, producing a light and floury consistency, a change which is necessary if starch is to be digestible. In order to effect this bursting of the starch granules, a temperature as high as boiling point of water must be used; hence the rule that vegetables always require, for a part of the time of cooking at any rate, a high temperature equal to that of boiling water, but that meat should, as a rule, be cooked at a temperature below that of boiling water.

ON SOME RECENT INVESTIGATIONS OF THE GEOLOGY OF THE PUNJAB SALT RANGE.

By G. W. BULMAN, M.A., B.Sc.

THE Salt Range is one of the many special features of interest in Indian geology: many new geological ideas are suggested by a study of its various formations. In the rocks of the Salt Range, Dr. Waagen made his important discovery of *ammonites* associated with *productus*, *spirifer*, *streptorhynchus*, &c.—in other words, they contain rocks of carboniferous age; in them Dr. Oldham found indications of a palæozoic ice age in India, in the form of the celebrated boulder bed. In them, again, Dr. Warth has discovered the first remains of *trilobites* yielded by Indian rocks, and in the Salt Range the almost universal break between the palæozoic and mesozoic rocks is absent; carboniferous rocks pass up without interruption into triassic.

Among the more special features of interest in the rocks of the Salt Range may be mentioned: (1) the clear and unbroken succession of the different systems, uncomplicated by igneous intrusions, and unobscured by metamorphism or crumpling; (2) the distinctness of the sections owing to the absence of vegetation, and the well-marked colours of the different formations; (3) the occurrence in the carboniferous system, along with its own characteristic fossils, of *ammonites*, and the distinctly triassic form *ceratites*: (4) the peculiar nature of certain beds—as, for example, the palæozoic boulder-clay known as the boulder bed, and the salt marl.

Two interesting and very suggestive papers on these rocks were published in the "Records of the Geological Survey of India" for 1891.

In the first of these, Mr. Middlemiss refers to the vivid impression produced by the first sight of the wonderful features of the Salt Range, where in a single section the eye can take in a series of sharply-defined formations, ranging from palæozoic to tertiary, and following each other in apparently unbroken succession; where we may see series of strata as free "from the dust of time as an uncut volume fresh from the binder's hands." One of the main objects of Mr. Middlemiss's survey of the Salt Range was to verify Dr. Warth's discovery of fragments of trilobites (*conocephalites* and *olenus*); and this was fully accomplished, fragments of trilobites and brachiopoda having been found, fixing the age of the rocks in which they occur as Cambrian. A remarkable fact about these ancient rocks is that, in spite of their great age, they have been unaffected by disturbances of the earth's crust during the whole of the enormous period which has elapsed since their formation.

The more important features in the two papers referred to are the investigations of the lower bed known as the salt marl.

In the "Manual of the Geology of India," the remarkable resemblance of this formation, with its thick beds of rock salt, its gypsum, and its anhydrite, to the trias of our own country is pointed out, and a similar origin suggested. In other words, this salt marl, of probably Cambrian age, is supposed to have originated in a salt lake or lakes. The main point in Mr. Middlemiss's interesting paper is the total rejection of the marine hypothesis, and the suggestion that the salt marl has originated from what may be termed smothered volcanic action.

Mr. Middlemiss notes the following points which seem to be inconsistent with the idea that the salt marl is of Cambrian age and of sedimentary origin:—

1. Its soft and homogeneous nature.
2. The absence of definite stratification.
3. Its method of occurring mixed up with different formations.
4. The occurrence on the other side of the Indus of other salt-bearing beds, only a short distance off, and yet supposed to be of tertiary age.

In its structure and composition the salt marl is a remarkable formation. It is a soft red marl, associated with immense masses of rock salt and gypsum. Except where it encloses masses of dolomitic rock, or where associated with beds of gypsum and rock salt, it never shows any signs of stratification, or traces of divisional planes. Seen even in large masses on the hill-sides it shows no structural planes; nor does it exhibit any trace of colour banding. Another peculiarity is the absence of grains of sand and pebbles of foreign origin, which shows

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that it is not a sedimentary rock. The total absence of organic remains tends to the same conclusion. There is, in fact, a lack of all positive evidence for a sedimentary origin of these beds.

Gypsum and dolomite occur in the red marl in a remarkable manner, which receives from Mr. Middlemiss an ingenious explanation in accordance with his view as to the origin of the formation. The gypsum occurs as a network, or sponge-work of anastomosing strings; the dolomite in vesicular or honey-combed lumps of irregular shape and size. Besides these, there occur in the marl numerous pale greenish-grey patches, varying in size from an inch across to mere specks. Every gradation may be traced from these to the honey-combed dolomite. As the latter become more honey-combed, they split up into corroded fragments of dolomite, and these latter, again, into the greenish grey specks and patches. They become, in fact, a part of the marl. As Mr. Middlemiss remarks, the red marl "seems to have devoured the dolomite, to have absorbed or digested it just as a pot of molten lead absorbs the solid bits thrown into it."

A parallel change from dolomite to gypsum also occurs. Roughly-bedded dolomite, solid in its central portion, is found to be crumbling and honey-combed at the edges. The following series of changes occur:—

First, the hard, flinty-looking rock becomes dotted with minute punctures in rows or nebulous patches. Then larger ragged holes appear, themselves bordered by minute punctures. Canals, sometimes roughly following the joint planes of the dolomite, join these larger holes. Another phase in the gradual change is dolomite with a honey-combed structure. The joint planes are converted into widened fissures, and along the cracks and holes gypsum takes the place of the dolomite. Finally lumps of dolomite are honey-combed to a spongy, and then to a reticulate fibrous texture, the holes and meshes being occupied by gypsum.

The general position and stratigraphical relations of the salt marl furnish further arguments against its sedimentary origin. Above the red marl lies the purple sandstone, and it has been held that there is a normal passage of the red marl into the purple sandstone, such as to indicate a continuous sequence between the two formations. Mr. Middlemiss contends that there is not such a normal passage. Continuous sequence, he asserts, is best shown by the *interbedding* of the one formation with the other; alternating layers of the one and the other dovetailing the two formations together. This is not found; nor could Mr. Middlemiss satisfy himself that there is any rock intermediate in composition between the marl and the sandstone between them. In exposed sections showing the junction, it is pointed out that the layer of rock marking the junction is brecciated. In one section the junction-marking breccia of fragments of purple sandstone in a matrix of marl is explained by Mr. Middlemiss as possessing the appearance of one formed by *the intrusion of one rock into another*.

Other sections are brought forward to show that the red marl must have possessed a plasticity and power of movement *after* the deposition of many of the formations above it. Where the marl is overlaid by a boulder bed, the latter never contains fragments or boulders of marl. At the same time the boulder bed does contain fragments of dolomite similar to the unaltered portion of the dolomite of the red marl. From this Mr. Middlemiss infers that the dolomite of the red marl represents an original rock at least older than the boulder bed; while the red marl, gypsum, and altered dolomite are of more recent age. And in a section where the marl occupies the core of a sigma-flexure, while the other formations included in the flexure are sheared, the marl is not. The conclusion from such a section seems to be that the marl band had been forced in a plastic or liquid condition among the other rocks, and had solidified under conditions of no strain. In another section the red marl exhibits one of the distinguishing characters of intrusive rocks; it alters its horizon with regard to the accompanying sedimentary beds—that is to say, from a position in one place below the speckled sandstone, it passes to one above it. In other places the salt marl is overlaid by the orange series (younger tertiary), and it is concluded that the junction cannot be a normal one due to the deposition of these beds on an exposed reef of salt marl.

To account for all the above remarkable, and on the sedimentary theory anomalous, features of the red marl of the Salt Range, Mr. Middlemiss suggests a remarkable hypothesis of arrested volcanic action. The striking absence of all outward tokens of volcanic activity, metamorphism and disturbance generally, in the region under consideration is pointed out. Thus it would appear that the subterranean magmas have remained sealed up since the earliest era of sedimentation; but the upper surface of the molten mass would solidify, and it is suggested that the scum thus formed is represented by the salt marl. The dolomitic masses are accounted for by the alteration produced on overlying dolomitic rocks by this subterranean mass.

In the second paper, Mr. Holland furnishes some interesting notes on the chemical and physical characters of rock specimens from the Salt Range, and in a certain degree confirms the hypothesis suggested by Mr. Middlemiss. We have first an examination of the bi-pyramidal quartz crystals, the "Marf diamonds" of the natives. These crystals are found embedded in the gypsum, and vary in size from a millet seed to that of a walnut. In colour they vary from white through shades of pink to brick red, and in the centre of each crystal there is a white or pink translucent core. The perfection of the crystals, and the absence of all traces of rounding, is held to be rather characteristic of their formation in a yielding liquid magma than in an ordinary sedimentary formation. Microscopical examination and analysis showed that these translucent cores are due to inclusions of anhydrite. The conclusion to be derived from this seems to be that the quartz crystals were formed in the midst of a matrix of anhydrite, and that afterwards the anhydrite was hydrated to gypsum; and a study of the gypsum itself shows clearly that it has been formed by the action of water on anhydrite. Specimens examined were found to be partly anhydrite and partly gypsum. In some the alteration to gypsum occurred along cracks and cleavage planes. The expansion which accompanies this change has left its mark, and displacements of fragments, faulting of twinning and cleavage planes, are observable under the microscope. In some cases the crystals have been fractured, and the fragments scattered along lines so as to produce a foliated structure, sometimes observable in hand specimens.

Mr. Holland concludes from his studies that the gypsum masses are not of aqueous or sedimentary origin. He suggests further that the anhydrite may have been produced by the action of sulphuric acid on limestone at high temperatures, and with presence of superheated waters.

As to Mr. Middlemiss's hypothesis of arrested volcanic action opinions may differ, but it must be admitted that these two papers render extremely probable the conclusion that the red marl of the Salt Range is not an ordinary sedimentary rock.

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THE FACE OF THE SKY FOR JULY.

By HERBERT SADLER, F.R.A.S.

SUNSPOTS are still very prevalent. There is no real night till after the 20th of July, but either daylight or twilight. A maximum of the beautiful red variable star, R Leonis, occurs on July 4th.

Mercury is an evening star, and sets on the 1st at 9h. 43m. P.M., or 1h. 26m. after the Sun, with a northern declination of 20° 23′, and an apparent diameter of $6\frac{1}{2}''$, $\frac{60}{100}$ths of the disc being illuminated. On the 5th he sets at 9h. 36m. P.M., or 1h. 20m. after sunset, with a northern declination of 19° 2′, and an apparent diameter of $7\frac{1}{4}''$, $\frac{52}{100}$ths of the disc being illuminated. On the 10th he sets at 9h. 23m. P.M., or 1h. 9m. after sunset, with a northern declination of 16° 6′, and an apparent diameter of 8″, $\frac{44}{100}$ths of the disc being illuminated. He is at his greatest elongation ($26\frac{1}{2}°$) on the 12th. On the 15th he sets at 9h. 7m. P.M., or 58m. after the Sun, with a northern declination of 13° 49′, and an apparent diameter of $8\frac{1}{2}''$, $\frac{36}{100}$ths of the disc being illuminated. After this he approaches the Sun too closely to be observed. While visible he describes a direct path through part of Cancer into Leo.

Venus is an evening star, and sets on the 1st at 9h. 20m. P.M., or 1h. 3m. after the Sun, with a northern declination of 22° 15′, and an apparent diameter of $50\frac{1}{4}''$, $\frac{96}{100}$ths of the disc being illuminated. On the 15th she sets at 9h. 13m. P.M., or 1h. 4m. after the Sun, with a northern declination of 18° 20′, and an apparent diameter of $10\frac{1}{2}''$, $\frac{94}{100}$ths of the disc being illuminated. On the 31st she sets at 8h. 49m. P.M., or 1h. 2m. after the Sun, with a northern declination of 11° 54′, and an apparent diameter of 11″, $\frac{9}{10}$ths of the disc being illuminated. She is in conjunction with Mars at 2 P.M. on the 9th, Venus being 18′ to the north. She describes a direct path from Gemini across Cancer into Leo.

Both Mars and Neptune are, for the observer's purposes, invisible, and as Jupiter does not rise till 11h. 18m. P.M. on the last day of the month we defer an ephemeris of him till August.

Saturn is an evening star, but should be looked for as soon after sunset as possible. He sets on the 1st at 11h. 50m. P.M., with a southern declination of 0° 20′, and an apparent equatorial diameter of 17″ (the major axis of the ring system being 39″ in diameter, and the minor 4·3″). On the 15th he sets at 10h. 56m. P.M., with a southern declination of 0° 39′, and an apparent equatorial diameter of $16\frac{1}{2}''$ (the major axis of the ring system being $38\frac{1}{4}''$ in diameter, and the minor $4\frac{1}{2}''$). On the 31st he sets at 9h. 54m. P.M., with a southern declination of 1° 8′, and an apparent equatorial diameter of 16″ (the major axis of the ring system being $37\frac{1}{4}''$ in diameter, and the minor 4·7″). He will be occulted by the Moon on the 19th, but the phenomenon will only be visible in the southern hemisphere. Iapetus is in superior conjunction on the 21st. A map of the path of Saturn during July will be found in the "Face of the Sky" for March.

Uranus is also an evening star, but, like Saturn, should be looked for as soon after sunset as possible, as his great southern declination is a bar to observation. He rises on the 1st at 2h. 43m. P.M., with a southern declination of 13° 21′, and an apparent diameter of 3·7″. On the 30th he sets at 10h. 34m. P.M., with a southern declination of 13° 22′. A map of his path during July will be found in the "Face of the Sky" for April.

Shooting stars are fairly numerous in July, though the twilight interferes with observation. A well-marked shower radiates from near δ Aquarii, the maximum being on the 28th. The radiant point is in 22h. 40m. — 13°.

The Moon enters her last quarter at 10h. 5m. P.M. on the 6th; is new at 6h. 47m. P.M. on the 13th; enters her first quarter at 5h. 2m. P.M. on the 20th, and is full at 8h. 10m. P.M. on the 28th. She is in perigee at midnight on the 11th (distance from the earth 224,130 miles), and in apogee at 2h. A.M. on the 24th (distance from the earth 251,640 miles).

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

ALL COMMUNICATIONS for this column should be addressed to the "CHESS EDITOR, *Knowledge Office*," and posted before the 10th of each month.

Solution of June Problem (S. Loyd):—

Key-move, 1. Kt to QKt4.

If 1. . . . R × P, 2. Kt to Q6ch, &c.
If 1. . . . R to Kt3ch, 2. Kt × R.
If 1. . . . R to Q3, 2. Kt × Rch.
If 1. . . . R to Ksq, 2. B to Q5ch.
If 1. . . . Anything else, 2. B to Q5, &c.

In spite of the hint appended to the diagram last month, no correct solutions have been received. Those who have sent in 1. Kt (Q5) to Kt6 (why not equally Kt to B3 or K3?) have overlooked the ingenious defence provided by the composer. This defence is not mentioned above, as after the correct key-move it loses its merit. Perhaps solvers would like to search for it again. As a direct clue, we give the following position (ascribed to Mr. W. Donisthorpe):—*White:* K at KKtsq, B at QRsq, Kt at KB6, P at KR6. *Black:* K at KRsq, B at QB3, P at KKt6. White mates in five moves. The point is that there is no mate in four moves, the idea being similar to Mr. Loyd's. Solutions will be acknowledged.

Alpha, H. S. Brandreth, R. B. Cooke, R. Inwards.—Nearly right, but the position is worth looking at again.

A. E. W.—See solution above.

A. G. Fellows.—Your third problem arrived just too late to notice last month. You can hardly have examined the position, at least four solutions being easily discoverable.

Solution of Prof. Valle's Problem.

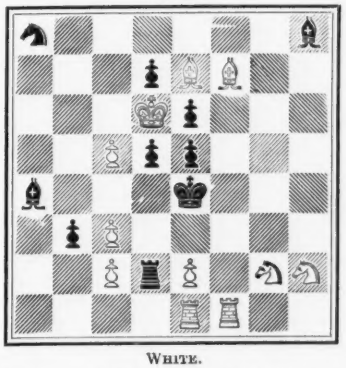
1. R to QKt4, and mates next move.

Correctly solved by Alpha and R. B. Cooke.
The near "try," R to QR4, is met by R × QP.

PROBLEM.

By G. K. ANSELL.

BLACK.



WHITE.

White compels Black to mate in two moves.

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A parallel change from dolomite to gypsum also occurs. Roughly-bedded dolomite, solid in its central portion, is found to be crumbling and honey-combed at the edges. The following series of changes occur:—

First, the hard, flinty-looking rock becomes dotted with minute punctures in rows or nebulous patches. Then larger ragged holes appear, themselves bordered by minute punctures. Canals, sometimes roughly following the joint planes of the dolomite, join these larger holes. Another phase in the gradual change is dolomite with a honey-combed structure. The joint planes are converted into widened fissures, and along the cracks and holes gypsum takes the place of the dolomite. Finally lumps of dolomite are honey-combed to a spongy, and then to a reticulate fibrous texture, the holes and meshes being occupied by gypsum.

The general position and stratigraphical relations of the salt marl furnish further arguments against its sedimentary origin. Above the red marl lies the purple sandstone, and it has been held that there is a normal passage of the red marl into the purple sandstone, such as to indicate a continuous sequence between the two formations. Mr. Middlemiss contends that there is not such a normal passage. Continuous sequence, he asserts, is best shown by the *interbedding* of the one formation with the other; alternating layers of the one and the other dovetailing the two formations together. This is not found; nor could Mr. Middlemiss satisfy himself that there is any rock intermediate in composition between the marl and the sandstone between them. In exposed sections showing the junction, it is pointed out that the layer of rock marking the junction is brecciated. In one section the junction-marking breccia of fragments of purple sandstone in a matrix of marl is explained by Mr. Middlemiss as possessing the appearance of one formed by *the intrusion of one rock into another*.

Other sections are brought forward to show that the red marl must have possessed a plasticity and power of movement *after* the deposition of many of the formations above it. Where the marl is overlaid by a boulder bed, the latter never contains fragments or boulders of marl. At the same time the boulder bed does contain fragments of dolomite similar to the unaltered portion of the dolomite of the red marl. From this Mr. Middlemiss infers that the dolomite of the red marl represents an original rock at least older than the boulder bed; while the red marl, gypsum, and altered dolomite are of more recent age. And in a section where the marl occupies the core of a sigma-flexure, while the other formations included in the flexure are sheared, the marl is not. The conclusion from such a section seems to be that the marl band had been forced in a plastic or liquid condition among the other rocks, and had solidified under conditions of no strain. In another section the red marl exhibits one of the distinguishing characters of intrusive rocks; it alters its horizon with regard to the accompanying sedimentary beds—that is to say, from a position in one place below the speckled sandstone, it passes to one above it. In other places the salt marl is overlaid by the orange series (younger tertiary), and it is concluded that the junction cannot be a normal one due to the deposition of these beds on an exposed reef of salt marl.

To account for all the above remarkable, and on the sedimentary theory anomalous, features of the red marl of the Salt Range, Mr. Middlemiss suggests a remarkable hypothesis of arrested volcanic action. The striking absence of all outward tokens of volcanic activity, metamorphism and disturbance generally, in the region under consideration is pointed out. Thus it would appear that the subterranean magmas have remained sealed up since the earliest era of sedimentation; but the upper surface of the molten mass would solidify, and it is suggested that the scum thus formed is represented by the salt marl. The dolomitic masses are accounted for by the alteration produced on overlying dolomitic rocks by this subterranean mass.

In the second paper, Mr. Holland furnishes some interesting notes on the chemical and physical characters of rock specimens from the Salt Range, and in a certain degree confirms the hypothesis suggested by Mr. Middlemiss. We have first an examination of the bi-pyramidal quartz crystals, the "Marf diamonds" of the natives. These crystals are found embedded in the gypsum, and vary in size from a millet seed to that of a walnut. In colour they vary from white through shades of pink to brick red, and in the centre of each crystal there is a white or pink translucent core. The perfection of the crystals, and the absence of all traces of rounding, is held to be rather characteristic of their formation in a yielding liquid magma than in an ordinary sedimentary formation. Microscopical examination and analysis showed that these translucent cores are due to inclusions of anhydrite. The conclusion to be derived from this seems to be that the quartz crystals were formed in the midst of a matrix of anhydrite, and that afterwards the anhydrite was hydrated to gypsum; and a study of the gypsum itself shows clearly that it has been formed by the action of water on anhydrite. Specimens examined were found to be partly anhydrite and partly gypsum. In some the alteration to gypsum occurred along cracks and cleavage planes. The expansion which accompanies this change has left its mark, and displacements of fragments, faulting of twinning and cleavage planes, are observable under the microscope. In some cases the crystals have been fractured, and the fragments scattered along lines so as to produce a foliated structure, sometimes observable in hand specimens.

Mr. Holland concludes from his studies that the gypsum masses are not of aqueous or sedimentary origin. He suggests further that the anhydrite may have been produced by the action of sulphuric acid on limestone at high temperatures, and with presence of superheated waters.

As to Mr. Middlemiss's hypothesis of arrested volcanic action opinions may differ, but it must be admitted that these two papers render extremely probable the conclusion that the red marl of the Salt Range is not an ordinary sedimentary rock.

THE FACE OF THE SKY FOR JULY.

By HERBERT SADLER, F.R.A.S.

SUNSPOTS are still very prevalent. There is no real night till after the 20th of July, but either daylight or twilight. A maximum of the beautiful red variable star, R Leonis, occurs on July 4th.

Mercury is an evening star, and sets on the 1st at 9h. 43m. P.M., or 1h. 26m. after the Sun, with a northern declination of 20° 23′, and an apparent diameter of $6\frac{1}{2}''$, $\frac{60}{100}$ths of the disc being illuminated. On the 5th he sets at 9h. 36m. P.M., or 1h. 20m. after sunset, with a northern declination of 19° 2′, and an apparent diameter of $7\frac{1}{4}''$, $\frac{52}{100}$ths of the disc being illuminated. On the 10th he sets at 9h. 23m. P.M., or 1h. 9m. after sunset, with a northern declination of 16° 6′, and an apparent diameter of 8″, $\frac{44}{100}$ths of the disc being illuminated. He is at his greatest elongation ($26\frac{1}{2}°$) on the 12th. On the 15th he sets at 9h. 7m. P.M., or 58m. after the Sun, with a northern declination of 13° 49′, and an apparent diameter of $8\frac{1}{2}''$, $\frac{36}{100}$ths of the disc being illuminated. After this he approaches the Sun too closely to be observed. While visible he describes a direct path through part of Cancer into Leo.

Venus is an evening star, and sets on the 1st at 9h. 20m. P.M., or 1h. 3m. after the Sun, with a northern declination of 22° 15′, and an apparent diameter of $50\frac{1}{4}''$, $\frac{96}{100}$ths of the disc being illuminated. On the 15th she sets at 9h. 13m. P.M., or 1h. 4m. after the Sun, with a northern declination of 18° 20′, and an apparent diameter of $10\frac{1}{2}''$, $\frac{94}{100}$ths of the disc being illuminated. On the 31st she sets at 8h. 49m. P.M., or 1h. 2m. after the Sun, with a northern declination of 11° 54′, and an apparent diameter of 11″, $\frac{90}{100}$ths of the disc being illuminated. She is in conjunction with Mars at 2 P.M. on the 9th, Venus being 18′ to the north. She describes a direct path from Gemini across Cancer into Leo.

Both Mars and Neptune are, for the observer's purposes, invisible, and as Jupiter does not rise till 11h. 18m. P.M. on the last day of the month we defer an ephemeris of him till August.

Saturn is an evening star, but should be looked for as soon after sunset as possible. He sets on the 1st at 11h. 50m. P.M., with a southern declination of 0° 20′, and an apparent equatorial diameter of 17″ (the major axis of the ring system being 39″ in diameter, and the minor 4·3″). On the 15th he sets at 10h. 56m. P.M., with a southern declination of 0° 39′, and an apparent equatorial diameter of $16\frac{1}{2}''$ (the major axis of the ring system being $38\frac{1}{4}''$ in diameter, and the minor $4\frac{1}{2}''$). On the 31st he sets at 9h. 54m. P.M., with a southern declination of 1° 8′, and an apparent equatorial diameter of 16″ (the major axis of the ring system being $37\frac{1}{4}''$ in diameter, and the minor 4·7″). He will be occulted by the Moon on the 19th, but the phenomenon will only be visible in the southern hemisphere. Iapetus is in superior conjunction on the 21st. A map of the path of Saturn during July will be found in the "Face of the Sky" for March.

Uranus is also an evening star, but, like Saturn, should be looked for as soon after sunset as possible, as his great southern declination is a bar to observation. He rises on the 1st at 2h. 43m. P.M., with a southern declination of 13° 21′, and an apparent diameter of 3·7″. On the 30th he sets at 10h. 34m. P.M., with a southern declination of 13° 22′. A map of his path during July will be found in the "Face of the Sky" for April.

Shooting stars are fairly numerous in July, though the twilight interferes with observation. A well-marked shower radiates from near δ Aquarii, the maximum being on the 28th. The radiant point is in 22h. 40m. — 13°.

The Moon enters her last quarter at 10h. 5m. P.M. on the 6th; is new at 6h. 47m. P.M. on the 13th; enters her first quarter at 5h. 2m. P.M. on the 20th, and is full at 8h. 10m. P.M. on the 28th. She is in perigee at midnight on the 11th (distance from the earth 224,130 miles), and in apogee at 2h. A.M. on the 24th (distance from the earth 251,640 miles).

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

ALL COMMUNICATIONS for this column should be addressed to the "CHESS EDITOR, *Knowledge Office*," and posted before the 10th of each month.

Solution of June Problem (S. Loyd) :—

Key-move, 1. Kt to QKt4.

If 1. . . . R × P, 2. Kt to Q6ch, &c.
If 1. . . . R to Kt3ch, 2. Kt × R.
If 1. . . . R to Q3, 2. Kt × Rch.
If 1. . . . R to Ksq, 2. B to Q5ch.
If 1. . . . Anything else, 2. B to Q5, &c.

In spite of the hint appended to the diagram last month, no correct solutions have been received. Those who have sent in 1. Kt (Q5) to Kt6 (why not equally Kt to B3 or K3 ?) have overlooked the ingenious defence provided by the composer. This defence is not mentioned above, as after the correct key-move it loses its merit. Perhaps solvers would like to search for it again. As a direct clue, we give the following position (ascribed to Mr. W. Donisthorpe) :—*White:* K at KKtsq, B at QRsq, Kt at KB6, P at KR6. *Black:* K at KRsq, B at QB3, P at KKt6. White mates in five moves. The point is that there is no mate in four moves, the idea being similar to Mr. Loyd's. Solutions will be acknowledged.

Alpha, H. S. Brandreth, R. B. Cooke, R. Inwards.—Nearly right, but the position is worth looking at again.

A. E. W.—See solution above.

A. G. Fellows.—Your third problem arrived just too late to notice last month. You can hardly have examined the position, at least four solutions being easily discoverable.

Solution of Prof. Valle's Problem.

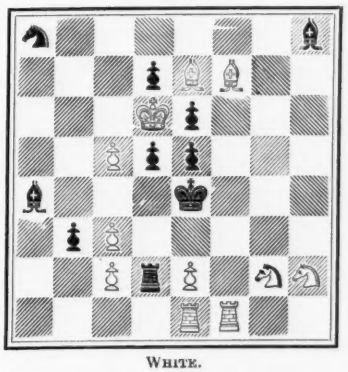
1. R to QKt4, and mates next move.

Correctly solved by Alpha and R. B. Cooke.
The near "try," R to QR4, is met by R × QP.

PROBLEM.

By G. K. ANSELL.

BLACK.



WHITE.

White compels Black to mate in two moves.

The following game was recently played in a match at the Metropolitan Chess Club. The score is from the *Daily News*:—

"VIENNA OPENING."

WHITE (H. Jacobs).	BLACK (R. Loman).
1. P to K4	1. P to K4
2. QKt to B3	2. KKt to B3
3. P to KKt3	3. P to Q4 (*a*)
4. P × P	4. Kt × P
5. B to Kt2	5. B to K3
6. Q to K2 (*b*)	6. QKt to B3
7. Q to Kt5 (?)	7. P to QR3 (*c*)
8. Q to R4	8. B to K2
9. Kt to B3	9. Castles
10. Castles (*d*)	10. KKt to Kt5
11. P to QR3	11. P to QKt4
12. Kt × KtP	12. P × Kt
13. Q × P	13. R to R4
14. Q to K2	14. Kt × P
15. R to Ktsq	15. KKt to Q5
16. Q to Ksq	16. Kt × Ktch (*e*)
17. B × Kt	17. Kt to Q5
18. B to K4 (*f*)	18. B to R6
19. P to Q3 (*g*)	19. R to B4
20. P to QKt4	20. R to B7 and wins (*h*)

NOTES.

(*a*) This gives White the Steinitz defence to the "Three Knights game," with the advantage of a move ahead. We much prefer 3. . . B to B4, followed by P to QR3 (to preserve the Bishop); and, directly White Castles, P to KR4, with a dangerous attack.

(*b*) White elects to use his "move ahead" as an aid to Pawn-hunting. Kt to B3 and Castles would be a much better course.

(*c*) Prettily played. If now 8. Q × KtP, Kt to QR4 wins the Queen.

(*d*) This loses a piece. Q to K4 was now essential.

(*e*) 16. . . B to R7 is more decisive. 16. . . B to B5 would equally win the exchange.

(*f*) Nullifying the effect of B to R7 and B to B5, but letting the Bishop in at another door.

(*g*) Probably overlooking the fact that he can avoid further loss by 19. B to Kt2, B × B; 20. K × B, Q to Q4ch; 21. P to B3, Q to R7; 22. Q to K4, P to B4; 23. Q to Q3. This and his next move simply bring the Black Rook into play.

(*h*) *E.g.*, 21. B to Kt2, Kt to K7ch, followed by B × Bch and Q to Q4ch.

CHESS INTELLIGENCE.

The match between Messrs. Bird and Jasnagrodsky was finally abandoned as drawn, each player having won six games, with three games drawn.

Messrs. Loman and Herbert Jacobs are now playing a return match at the Metropolitan Chess Club. Mr. Loman won the first match somewhat easily by 5 games to 1.

The annual match at Paris between a weak team of the British Chess Club and the Grand Cercle des Echecs resulted in a victory for the Parisians by $4\frac{1}{2}$ to $2\frac{1}{2}$.

At Cambridge chess and mathematics go hand in hand. Mr. H. E. Atkins, the best undergraduate player at either University for the last three years, is bracketed ninth wrangler this year.

A match was played at Brighton on June 10th between Sussex and the City of London Chess Club. The London Club was not very strongly represented, but strong enough to win the match by 11 games to 9.

The *Hackney Mercury* announces a sui-mate Tourney for two, three, and four movers. Problems, not more than two in any one section, should be sent to 101, Queen's Road, Dalston, N.E., before September 1st.

Chess History and Reminiscences, by H. E. Bird (Dean and Son). Mr. Bird, though not so old as he looks, is still the *doyen* of English Chess Masters, and a volume of his reminiscences, ably edited, should be entertaining reading. Unfortunately, Mr. Bird felt also called upon to write a history of chess as she *was* played many centuries before his time. The result is merely a *résumé* of what has been written before, and certainly has not the atoning quality of good arrangement. Mr. Bird's historical style lacks the vivacity of his games, and the punctuation of the book is simply the worst on record. Still, the information here collected may, if correct, be not without its value to some future historian.

Mr. Bird has acquired some curious knowledge in his time. He knows, for instance, that "Italian sermons are unmethodical and unconnected, and full of sentences and maxims" (perhaps Italian preachers might retort with the *Tu quoque direct*). On the other hand, he "really does not know whether Homer really was 'neglected' (Mr. Bird's emendation for 'starved') by his country or not." After all, no man is omniscient.

The modern reminiscences are at times amusing, though some of the autobiography is perhaps not in the best possible taste, and many of the best anecdotes have already appeared in Mr. MacDonnell's *Chess Life Pictures*. But then Mr. Bird expressly states that he is "not a funny man, most reserved among his superiors, yet looks good-humoured." Like Mr. Pitt, he was formerly known as "the enemy of the human race," though no doubt the title lent itself to abbreviation.

The author's views on chivalry, enthusiasm, Ruskin, and rapidity are well known, and are naturally repeated here.

The book contains a portrait of the writer, without his characteristic expression, and deficient in the "lines of thought." But then we are told "many working men have sought wrinkles from Bird"; and this, perhaps, is the explanation.

For the "Chess Player's Annual and Club Directory, 1893 and 1894" (price 2s. 6d.), the authors, Mr. and Mrs. T. B. Rowland, Rus-in-Urbe, Kingstown, invite the following particulars of chess clubs:—Town, club name, year established, place of meeting, days, hours, number of members, annual subscription, laws, president, hon. secretary's name and address. Printed forms will be had on application.

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